Communications Systems Planning Bulletin

Prepared for: U.S. Air Force Directorate of Engineering and Services and
Dept. of the Army HQ U.S. Army Corps of Engineers

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Introduction

CHAPTER 1

INTRODUCTION

A. PURPOSE OF THE BULLETIN/MANUAL

1-1. This Communications System Planning Bulletin/Manual is one in a series of bulletins/manuals to support comprehensive planning at U.S. Military installations (Figure 1-1). This process is spelled out in Air Force Regulation AFR 86-4, "Base Comprehensive Planning" and in Army Regulation AR 210-20, "Master Planning for Army Installations". This Bulletin/Manual serves as a source for communications system planning principles and methodologies. It also serves as a guide to installation planners who are responsible for making short-term communications improvements and for developing the long-range communications component of the Base/Installation Comprehensive Plan, herein after referred to as the Plan. The expressed Army and Air Force goals of these documents are to:

1) Provide effective and efficient use of installation resources to support the mission.

2) Direct the long-range development of the installation.

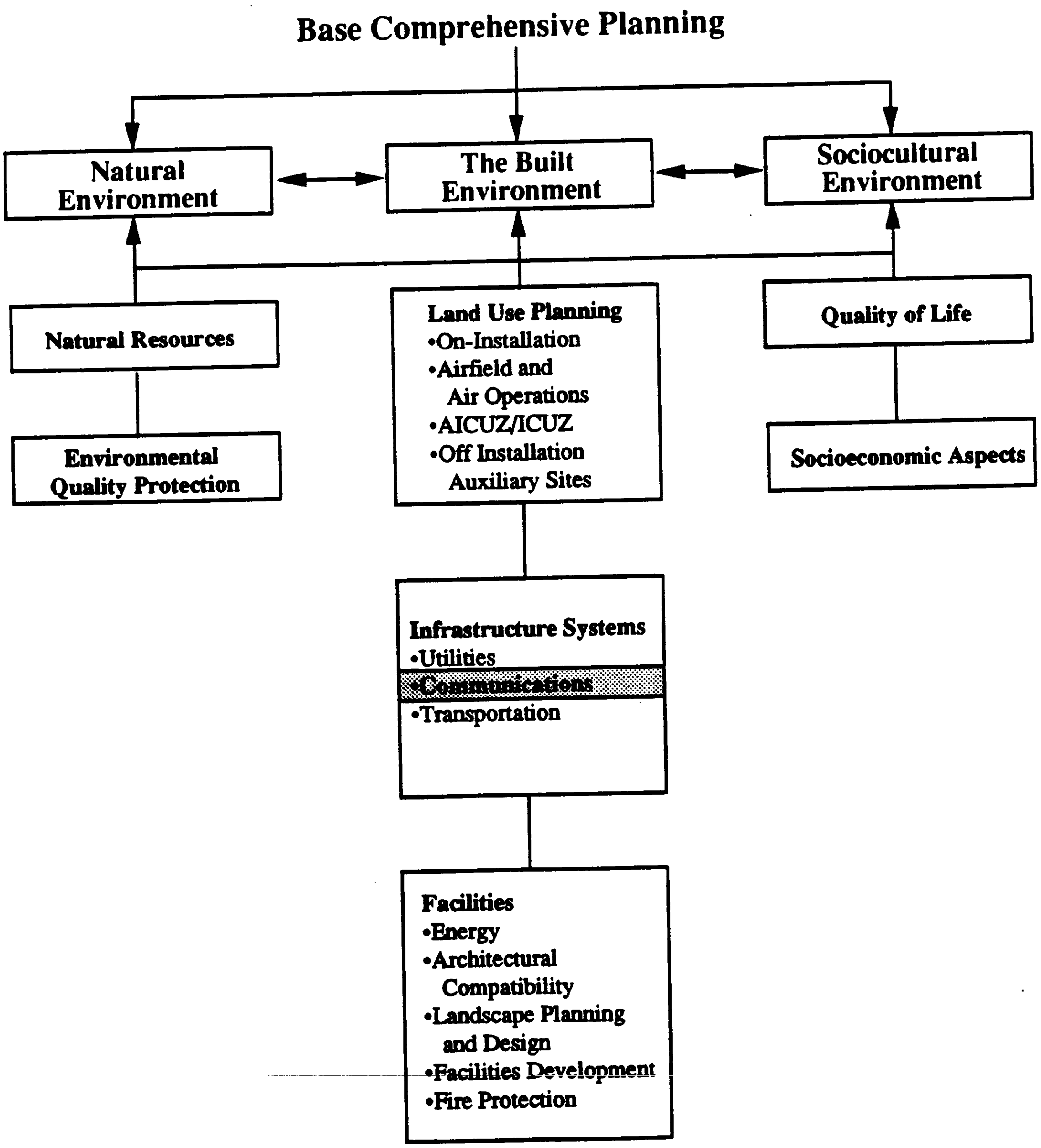
3) Integrate a number of interrelated functional programs derived from other component plans of The Plan.

4) Relate mission planning to policies, programs and specific projects for on installation facilities systems.

5) Relate the needs of the installation to the social, cultural and economic aspects of the surrounding civilian community.

6) Provide the basis for all decisions on siting of facilities, setting priorities and preparation of the Five-Year Defense Program (FYDP) and other capital improvement programs, and long-range facilities renovations and replacements.

7) Make optimal use of the latest developments in energy efficient concepts/systems/technologies.



Base Comprehensive Planning
Natural Environment
The Built Environment
Sociocultural Environment
Natural Resources
Environmental Quality Protection
Land Use Planning
•On-Installation
•Airfield and Air Operations
•AICUZ/ICUZ
•Off Installation Auxiliary Sites
Quality of Life
Socioeconomic Aspects
Infrastructure Systems
•Utilities
•Communications
•Transportation
Facilities
•Energy
•Architectural Compatibility
•Landscape Planning and Design
•Facilities Development
•Fire Protection

8) Protect the natural and human environment.

9) Provide the highest possible quality of life for the Air Force/Army community.

B. HOW TO USE THE BULLETIN/MANUAL

1-2. Scope and Content

a. The Communications Systems Planning Bulletin/Manual is one of a series of documents serving the U.S. Air Force's and U.S. Army's planning process. It is a resource document for installation planners who recommend or plan near- term and long-term improvements at their installations.

b. The scope of this Bulletin/Manual touches upon aspects of the Communications-Computer Systems (communications systems, cable, multi-user computer systems, microcomputers) as defined in Air Force Regulation (AFR) 700-2 and aspects of the Information Mission Area (IMA) responsibilities of the U.S. Army Information Systems Command (USAISC) (automation, communications, records management, printing and publications, and visual information) as defined in Army Regulation (AR) 25-1. However, the emphasis in this Bulletin/Manual is on the communications portions of the transfer of information, both voice and data, secure and non-secure. Given this approach, computer hardware and software considerations are only lightly touched upon throughout the Bulletin/Manual. Instead emphasis is placed on the pathways to transfer that information, be it by telephone line, microwave radio, satellite or video cable.

1-3. Terminology. Non-specific military terms have been used wherever possible in this document. In some ease, generic terms were devised to avoid using terms specific to the Army or Air Force. Please refer to the table below for the specific Army and Air Force definitions of these generic terms.

Generic	Army	Air Force
installation	post	base
the Plan (product)	the Installation Comprehensive Plan	the Base Comprehensive Plan (BCP)
the planner	master planner	community planner
comprehensive planning (process)	installation comprehensive planning	Base Comprehensive Planning
the engineer	Directorate of Engineering and Housing (DEH)	Base Civil Engineer (BCE)
moor command	MACOM	MAJCOM

1-4. Major commands, which are responsible for establishing communications programs for all their installations, should also be guided by the process in this Bulletin/Manual. This Bulletin/Manual can be used to:

1) help with day-to-day activities

2) produce a Communications Systems Plan with installation personnel as a special effort

3) produce a Communications Systems Plan with the assistance of the Communications/Information Systems Command

4) produce a Communications Systems Plan with consultant assistance.

This document primarily serves the BCE/DEH who is responsible for the installation comprehensive plan.

1.5 Bulletin/Manual Format. Topically, the Bulletin/Manual is organized as follows:

a. Chapter 1. Introduction. The Introduction describes the purpose of the Bulletin/Manual and incorporation of communications systems planning into the comprehensive planning process.

b. Chapter 2. Communications Systems Inventory Plan. This chapter presents the overall goals and objectives of the planning process and specific communications systems planning objectives. The approach to obtaining and assessing data and identifying opportunities and constraints is presented along with a description of siting criteria of communications systems facilities.

c. Chapter 3. Alternatives Evaluation. This chapter discusses methods of categorizing and evaluating alternatives for the purpose of determining a preferred alternative(s).

d. Chapter 4. Implementing and Monitoring. This chapter focuses on the implementation and monitoring process. Coordination of the communications systems plan with the other component plans of the Base/Installation Comprehensive Plan is also discussed.

e. Appendices. A more detailed discussion of the implications of EMI/RFI in communications systems planning on the installation is provided in Appendix A. A sample scope of work is contained in Appendix B. References are contained in Appendix C.

C. WHAT IS COMMUNICATIONS SYSTEMS PLANNING

1-6. The Concept

a. The communications system at an installation is like the nervous system of an organism. It supports the transfer of all sorts of information that are essential to maintaining basic functions and for responding to new and varied situations. As recent socioeconomic trends move us closer to an information-based society, the communications systems of all elements of the society take on an increasingly prominent role.

b. In a sense, the communications system at a military installation is quite similar to the transportation system. Both serve as a conduit to bring people closer together and to foster personal interactions essential to performing everyday activities and to maintaining military readiness. Both the communications system and the transportation system must operate efficiently as a network within the installation, and as a pathway to and from the world external to the installation. The transportation system moves people and goods from place to place. The communications system accomplishes its mission by shuttling electronically coded messages with great speed and agility. However, as the requirements for modern communications systems become ever more complex, careful, rational, long-range planning becomes a necessity. Such long-range communications planning must consider many inter-related factors. It must also be accomplished in concert with the fundamental process of the overall plan for the installation.

1.7 Parallel Planning Activities

a. Now that communications systems planning has been defined in concept, the approach taken in the present Bulletin/Manual is to consider it from two important and interrelated perspectives: 1) that of the communications systems planner/designed (at the major command level), and 2) that of the BCE/DEH (the Engineer). The emphasis for this document Is on the BCM/DEH (and the planner) at the Installation level In that they are responsible for Incorporating the communications systems plan Into the Plan. The Communications Systems Plan itself is often prepared by the Air Force Communications Command (USAF) or Information Systems Command (Army). The installation comprehensive plan reflects the impact of planned or projected communications systems as described in this former document. For this reason, the communications and civil engineering communities should be encouraged to openly interact as much as possible on all relevant planning activities. These two communities are already represented on the Facilities Board (Air Force) and the Installation Planning Board (Army).

b. One of the goals of the present Bulletin/Manual is to develop a better appreciation of the overall communications system planning process as a backdrop for increased cooperation between these two communities. For that reason, even though the primary audience for the present document Is at the Installation level, repeated reference is made to generic communications systems planning advice that should be important to both communities. This common generic advice is particularly important in the recent outlook adopted by the Air Force and the Army to regard the communications system at an installation as one integrated whole instead of a collection of disparate subsystems.

c. Throughout this Bulletin/Manual, repeated reference may be found to the two essential parallel planning processes that must ultimately fuse to create one consistent and coherent set of guideposts and recommendations. These are the command-level communications engineering planning process directed by AFR 700-2 and AR PAM 25-1 and the installation-level civil engineering/planning process directed by AFR 86A (Air Force) and AR 21~2O (Army). Although the concerns of each engineering community may be quite different, the planning processes must proceed in a parallel and coordinated fashion to ensure maximum military efficiency and readiness now and in the future.

The AFCC for the Air Force and USMC for the Army are responsible for communications systems planning in accordance with AFR 700-2 and AR 254, respectively. This planning effort provides data and background material for the comprehensive planning process prepared by the BCE/DEH in accordance with AFR 86-4 and AR 210-20.

d. For the Air Force, according to AFR 700-2, the Communication Systems Officer (CSO) on the installation follows the guidance and direction contained in the host major command's Communication Plan in developing an installation base assessment. (For the Army, the installation information systems engineer follows the guidance contained in the Information Systems Infrastructure Plan.) The installation follows the host communications structure for all host-provided communications services. The tenant major command's Communications Plans are considered in determining tenant requirements, and the tenant major command's plans are followed in providing solutions to tenant dedicated requirements.

e. Installation-level tenant organizations also follow the guidance and direction contained in their parent major command's Communications Plan, particularly for dedicated or command- unique capabilities. However, tenant organizations also participate in the host installation's planning process, and identify, for the communications systems staff, all future requirements that impact the installation's current and programmed capabilities. The installation Communications System Assessment contains all tenant requirements, including dedicated systems.

f. Communications systems planning must be integrated into other physical planning activities at the installation (Figure 1- 2). In this regard, communications planning is similar to utilities systems planning in that it is generally responsive and iterative in nature. For example, land use planning will often precede development of the communications systems plan. However, the Communication Systems Plan established by the major commands, sets forth the potential system alternative and often the siting requirements of facilities that respond to these existing, planned and future needs of the installation.

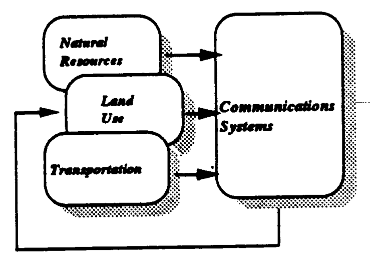


Figure 1-2

1-8. Who Is Involved In the Process

a. Many people are directly or indirectly involved in the Communications Systems planning process at the installation level. The key players include:

1) Installation Commander

2) The Communications System Officer (CSO) (Air Force) or the Director of Information Management (DOIM) (Army)

3) The Chief of Communications Plans and Program

4) The heads of key functional areas at the installation

5) The representative of tenant activities

6) Installation Civil Engineer (DEH/BCE)

7) The Facilities Board/Installation Planning Board

8) The Communications Systems Requirements Board (CSRB)

9) Base/Installation Environmental Management Division

10) The Installation/Community Planner

Key people involved in the planning process:
- ***Installation Commander***
- ***Communications System Officer***
- ***Chief of Communications Plans and Programs***
- ***Functional Area Managers***
- ***DEH/BCE***
- ***Facilities Board/Installation Planning Board***
- ***Planner***

b. In the context of this Bulletin/Manual, the Facilities Board refers to a generic decision-making body. At different installations it may be called by different names. The Base Facilities Board/Installation Planning Board has direct responsibility for Implementing the Communications Systems Plan Component that Is part of the Installation Comprehensive Plan. This board provides the corporate judgment for the effective use of resources, including Communications Systems resources. One of the explicit responsibilities of the Board is to review and approve the goals, objectives and component plans within the Communications Systems Plan.

c. At the installation level, the Air Force also has a communications-Computer Systems Requirements Board (CSRB) which is charged with validating, approving and prioritizing communications-computer systems requirements and technical solutions.

d. The above enumeration of persons and groups constitutes the key players at the installation level responsible for formulating, maintaining and monitoring the Communications Systems Plan. The communications unit on the installation, who is responsible for base-wide, non-contractor operated communications systems operations and maintenance, provides the most critical information for including in the Plan. In addition, those people within the BCB/DEH who have primary responsibility for the operation and maintenance of the contractor- operated components of the communications systems will also provide important input to the planning process.

D. THE COMMUNICATIONS SYSTEMS PLAN AS A COMPONENT OF THE PLAN

1-9. The Application

a. The Communications System Plan is just one element of the Plan (see Figure 1-1). The Communications Systems Plan must be coordinated with the other component plans and activities to ensure its proper integration into the planning process.

b. Planning is a rational decision-making sequence that attempts to direct activities and actions toward agreed upon goals and objectives. Communications systems planning establishes a baseline of present capabilities, defines future requirements and needs, identifies deficiencies in the present system, and lays out a road map of enhancements necessary to reach the final desired system.

c. Communications systems planning cannot be conducted in isolation. The communications system at a military installation interacts with almost every other planning activity and component and considerable coordination is required. Plan components particularly relevant to the Communications Systems Plan are the Land Use Plan, Natural Resources Plan, Transportation Plan, Utilities Plan, Fire Protection Plan, and AICUZ/ICUZ planning.

Plan components particularly relevant to Communications Systems Plan:
- ***Land Use***
- ***Natural Resources***
- ***Transportation***
- ***Long-Range Facility Development***
- ***Energy***
- ***Contingency***
- ***Utilities***

d. The Land Use Plan identifies land areas for all land uses currently on the installation and those likely to be needed within the planning time frame. The Communications Systems Plan must be developed in concert with these proposals. For example, these future facilities will require a range of communications functions, therefore, provisions for the appropriate connections and distribution networks must be incorporated into the land use philosophy. likewise, communications considerations may determine the appropriateness of certain land use patterns. Realizing that future land use and communications needs may be very different from those that currently exist requires considerable visionary thinking.

e. The Natural Resources Plan shows the present use of undeveloped land and major constraints such as topography, vegetation and other unique natural areas that must be considered in developing the Communications Systems Plan.

f. The Transportation Plan is used to determine the means to provide for safe and efficient movement of people and goods. Generally, this plan is developed according to the land use requirements and often serves as the basis for utility and communications distribution corridors. It is essential, therefore, that the transportation, land use, utilities and communications systems plans be considered in unison when considering future needs.

g. The Long Range Facilities Development Plan is the primary means to ensure that future new construction and the use and renovation of existing facilities and systems match the Land Use Plan. The Long Range Facilities Development Plan shows all relocations of activities into new or renovated facilities, expected demolition and replacement. It is also a pre-design plan that establishes roadways and parking, as well as utility alignments.

h. The Energy Plan is used to ensure that programs underway comply with the energy consumption goals for the installation. Energy conservation must be considered in developing the Communications Systems Plan, particularly if part of the energy plan is the development of an Energy Monitoring and Control System (EMCS). The EMCS will play a significant role in planning the communications system.

i. For the Air Force, contingency planning is an essential element of the Plan. (For the Army, mobilization planning is a comparable effort but not included in the Plan.) A separate bulletin/manual has been prepared that covers the issues related to combat effectiveness and contingency planning. The Communications Systems Plan, along with those of Land Use, Utilities and Transportation in particular, are key components which must reflect combat readiness capability in their recommendations for installation development. Although it is not possible to protect an installation against all possible emergencies all of the time, many improvements can be made through the arrangement of land uses, the routing of transportation and utility (including communications) systems, and the location, orientation and design of facilities to reduce their vulnerability to outside threats. The most effective and least costly protective measures are those incorporated during plan development, project site selection and facility design.

1-10. References. Appendix C contains references to several other military and civilian documents which complement this Communications Systems Planning Bulletin/Manual. These include other planning bulletins/manuals, AFCC and USAISC documents, and relevant Air Force and US Army Manuals.

1-11. Maps and Plans

a. A major product of the communications system planning process is a series of the system plan maps. These maps show the existing communications systems/facilities on the installation as well as establish the framework for future planning. These maps are contained in the Air Force's Tab H series and in the Army's existing conditions maps. Tab H series maps (per AFR 86A) include:

- Tab H-1: Basewide communications plans (prepared by the Air Force Communications Command and incorporated into the Plan by the BCE).

- Tab H-2: Other Onbase Communications Systems (prepared by the BCE).

- Tab H-3: NAVAIDS and Weather Facilities (optional; prepared by the BCE).

- Tab H-4: Composite of Tabs H-1 and H-2 (prepared by the BCE).

Communications systems maps for the Army (per AR 21O~ 20) would include telephone systems and cable television prepared by the DEH in accordance with TB ENG 353.

b. Both services use computer aided design and drafting (CADD) systems to generate base-wide planning maps. If such a system is available, it should be used to map existing communications systems and facilities as an overlay registered with other Tabs/existing conditions overlays and an installation base map. The objective is to strike a balance between data flexibility and production time. By instituting this system, both short-term and long-term efficiencies are gained by contractors and the Air Force/Army.

E. THE COMMUNICATIONS SYSTEMS PLANNING PROCESS

1-12. Approaches

a. The communication system planning process is generally initiated either from the top down or from the bottom up. In the Air Force, when the process is initiated from the top down, it usually comes in the form of policy and program directives from the Major Command, from the Air Force Communication Command (AFCC) or from Air Force Headquarters (HQ USAF). A good example of such direction from above is the series of guidance documents entitled "Air Force Communications - Computer Systems Architecture" (AFP 700-5, Volumes 1-9). In the Army, top-down initiation of the process generally comes from the Major Command, the Army Information Systems Command (USAISC) or from the Department of the Army (DA). A parallel example of downward directed guidance for the Army is the "Army Information Resource Management Program" (AR 25-1).

b. When the communications systems planning process is initiated from the bottom up, it generally comes in the form of a concrete request to implement a needed change in present service. This request may range from the installation of an additional telephone set for a new billet, to the replacement and modernization of a massive multi-user computer network. A well- prepared Communications Systems Plan (typically prepared at the major command level) at the installation level can be extremely helpful in describing the requirements, justifications, impacts, proposed solutions, alternatives, acquisition strategies, projected costs and major milestones.

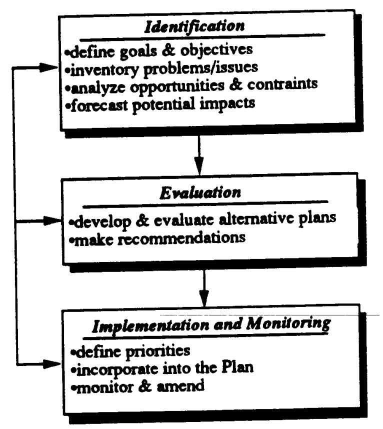
1-13. The Process. The three-step process that serves as to effectuate communications systems planning includes identification, evaluation, implementation and monitoring, shown in Figure 1-3 and summarized as follows:

a. Step 1, Identification. First, identify the general communications situation within and around the installation. This is accomplished by defining the communications systems, developing goals and objectives, performing an adequacy inventory of the current communications system, forecasting changes that are expected to occur, and finally analyzing these results for their current and future implications.

b. Step 2, Evaluation. Develop and evaluate alternative courses of action to address the communications situation. This evaluation will lead to prioritized recommendations that can then be included directly in the communications component of the Plan.

c. Step 3, Implementation and Monitoring. A thorough communications systems planning process will produce implementable recommendations. The prioritized recommendations are then transformed into the five-year capital improvement program, which includes all short-term recommendations. The long-term recommendations, developed in concert with the Land Use Plan, guide the implementation of the short-term improvements in facilities and services.

d. Systematic planning ensures that communications systems continue to meet user needs both on- and off-installation. Communications planning is not a one time effort, but rather is a process by which the Plan can be continually updated. To avoid obsolescence of the original communication plan, close interaction between the installation and the community must be maintained.



The Planning Process

Figure 1-3

e. In addition to the preparation of the communications component of the Plan, a Communications System Assessment is prepared at the installation level every other year, updated annually, as directed by the host major command (Integration and Implementation Guidance, Part III, MC-CSP). This assessment covers a five year period, and includes:

1) Evaluation of the base communication system.

2) Identification of deviations from the installation- level configuration.

3) Analysis of downward-directed policies.

4) Identification of important local requirements.

5) Assessment of system shortfalls.

6) Identification of required resources.

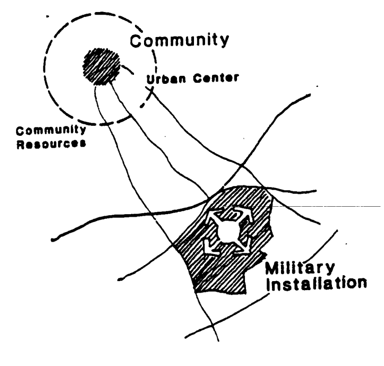
f. The Communications-Computer System Assessment will be published as scheduled by the host major command. After publication, this assessment is forwarded to the host major command for approval and to the tenant major commands for information. The Army follows a similar process as delineated in the "Army Information Resource Management Program" (AR 25-1) and its associated documentation. In either case, these assessments, although primarily generated by communications engineers, should be quite helpful to the planner who is responsible for preparing the Communications Systems Plan Component of the Plan.

F. RELATIONSHIP BETWEEN THE INSTALLATION AND THE COMMUNITY

1-14. A Joint Effort

a. Throughout the planning process, the communications systems planning must relate to the needs and constraints of both the installation and the surrounding community. Most installations are located adjacent to urban communities where a labor force and facilities for transportation, housing, utilities and communications services. are at least partially available. The greater the number of people employed and the higher the percentage of them residing off-installation, the more likely the communications interdependence of the community and the military installation.

b. Communities and military installations often have common problems relating to communications planning. New developments at the military installation can result in more telephone or radio traffic in the nearby community. Resources may be strained to provide commercial public telephone network access to and from the outside area. The high density of radio communications at the military installation may interfere with police, fire and emergency medical radio networks in the community. For example, antennas for intelligence listening may require radio-free quiet zones of many miles. Transmitting antennas also require large open areas for clearance zones to protect personnel from radiofrequency radiation hazards. Installations with these facilities could restrict urban development near the installation boundary. Furthermore, certain community communications activities can interfere with or limit military operational capability. For these reasons, it is essential to involve the community in as much of the communications systems planning process as is practical. Such involvement also makes for good community relations.



2

Communications Systems Inventory

CHAPTER 2

COMMUNICATIONS SYSTEMS INVENTORY

A. GOALS AND OBJECTIVES

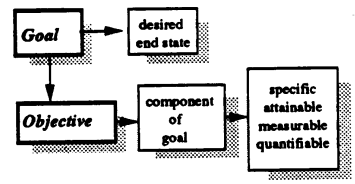
2-1. Direction and Baseline

a. Before the Communications Systems Plan component of the Base/Installation Comprehensive Plan (the Plan) can be prepared, the planner must have a point of departure. First, appropriate goals and objectives for improving communications capabilities must be established (Figure 2-1). These goals and objectives provide guidance for the remainder of the planning process. These goals and objectives may derive from the system- wide communications planning process, yet they must be consistent with the conditions and expectations at the installation level. They must also be consistent with the other component plans of the Plan - such as utilities, land use, transportation and natural resources.

b. At the same time, an inventory of current conditions must be conducted to determine what presently exists on the installation. This inventory (or periodic technical survey for the Air Force) should include characterizing the communications systems within the installation and, to a lesser extent, in the community surrounding the installation. The purpose of the inventory is to identity the scope and nature of any problems that exist, and to establish a database of information from which to predict future conditions. Thus, the goals and objectives provide the direction and focus and the current inventory provides the starting point, i.e. the baseline. When the goals are compared with the baseline, major deficiencies may often be identified. These deficiencies become the subject of the concrete communications system enhancements that form the raw material for the communications planning process.

2-2. Relating Communications Systems Goals to the Installation's Mission

a. The primary purpose of the comprehensive planning process is to support and enhance the operational mission of the installation. In this regard, it is important to define appropriate goals and objectives to guide the communications planning process toward a successful long-term outcome. Goals are general statements of desired ends and provide major direction to the planning effort. Objectives are developed from the goals and should be specific, attainable, and measurable. Each objective may call for setting up a number of criteria. Collectively, there may be a dozen or more criteria by which to measure a plan's effectiveness in its progress toward several goals. Table 2-1 gives an outline of sample communications systems goals for a hypothetical installation relative to the overall installation goals.



b. Goals and objectives may be broken down into short- and long-term statements, that in turn are formed into policies and program that give direction toward accomplishment of the goals and objectives. At the installation level, the planning process should be aimed at the factors that it can control. Local interoperability of command, control, communications and computer systems; the elimination of unneeded redundancy; the capacity of and need ~ expand the installation cable plant and telephone system; assimilation of Major Command and functional plans at the installation level; and the flexible use of the installation's operations and maintenance (O&M) budget are examples of communications objectives that the planning process should consider.

Table 2-1

Sample of Goals and Objectives

Mission: Support "XX" Fighter Wing

Overall Installation Goals:

1. Optimize land use.
2. Ensure adequate infrastructure.
3. Promote energy efficiency.
4. Maximize maintainability.
5. Conserve natural resources.
6. Ensure combat readiness.

Installation Communication Goals (Related to Overall Base Goal #2)

2A. Ensure that mission-essential communication needs of combat commanders are supported.

2B. Exploit communications/information as a resource to enhance mission effectiveness and efficiency in both wartime and peacetime.

2C. Ensure that mission-critical communications systems are as functionally survivable and enduring in stressed environments as the forces supported.

2D. Ensure that communications systems which process sensitive information provide an appropriate level of information protection.

2E. Exploit technology to improve the effectiveness and efficiency of communications/information systems to meet Air Force wartime and peacetime mission requirements.

Installation Communications Objectives (Related to Base Communications Goal 2D)

2D-1. Designate and isolate secure communications areas.

2D-2. Provide and maintain suitable encryption devices.

2D-3. Ensure proper separation for secure and nonsecure (red/black) communications traffic.

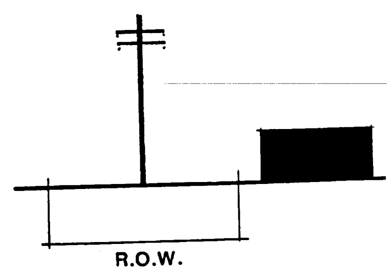
2D-4. Encourage the use of media that are difficult to tap (e.g., fiber optics).

c. The delineation of goals and objectives for the communications system must take into account two major factors: wartime requirements and mission and program changes:

1) Examples of wartime considerations include threats (physical, nuclear effects); survivability (degree of hardening, redundancy, diversity); endurability (ability to reconstitute and sustain operations); reliability (flexibility to provide information when and where needed); and the ability to support deployed units.

2) Mission and program changes include new weapon systems or new unit deployments and beddowns; reductions/deactivations; organizational changes; military construction (MILCON); minor construction; implementation of downward- directed communication system programs and functional programs; engineering and installation projects, including new requirements, modernization and local initiatives.

d. Communications goals are not totally separable from other installation goals relating to land use, transportation and utilities. Communications planners must work closely with all participants in the comprehensive planning process to ensure that the communication goals and objectives are compatible with other components of the Plan and with the goals and objectives in the surrounding communities. Planners and engineers at the installation level must work closely with communications systems planners in realizing these goals and objectives. In making technical tradeoffs for locating communications facilities, the civil engineering and land planning considerations of rights-of-ways, setbacks, separations, cable run lengths, etc. must be resolved in consonance with the overall communications systems goals and objectives.



R.O.W. for telephone, cable systems, etc. need to be coordinated in land use planning.

B. INVENTORY AND DATA COLLECTION

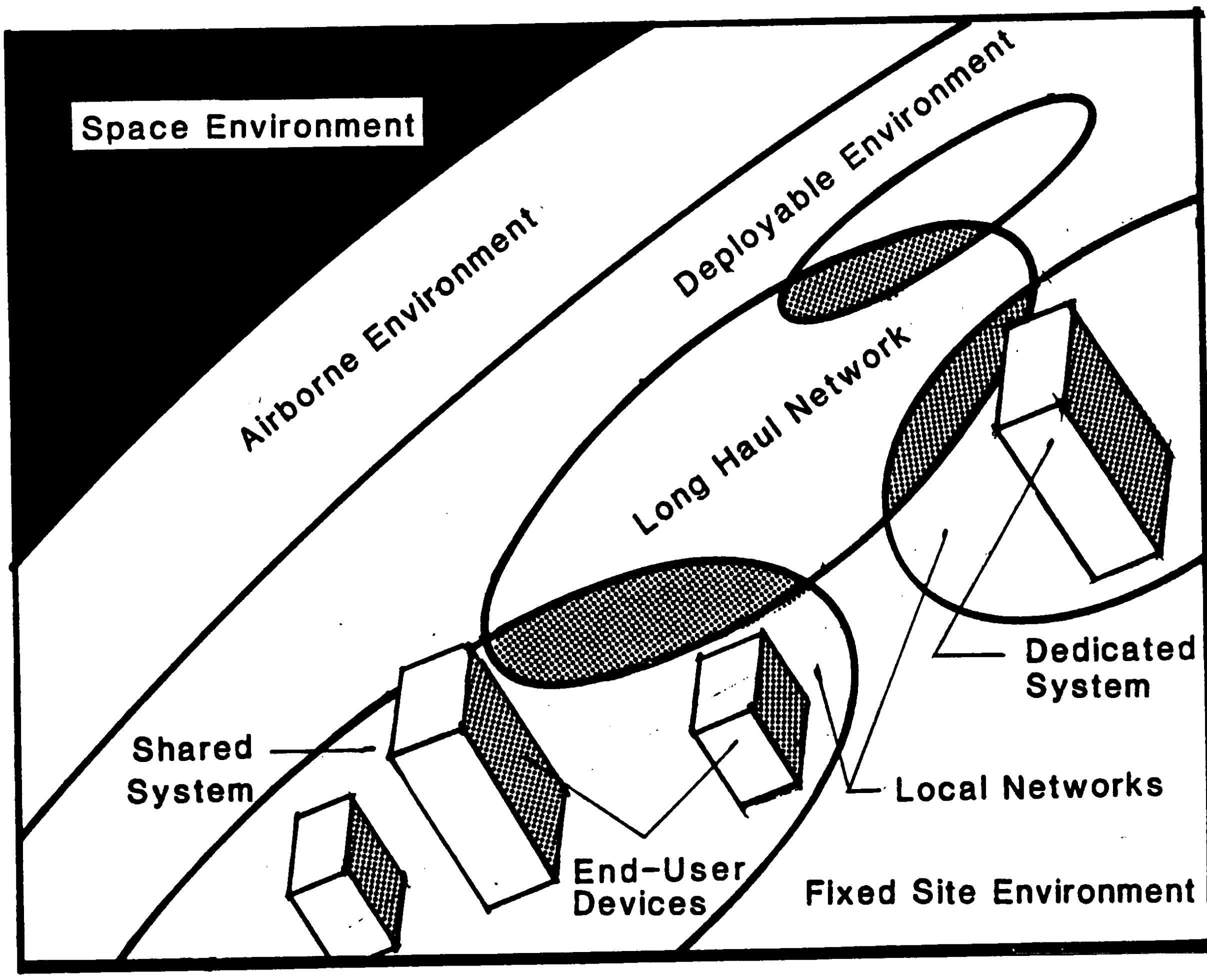
2-3. Assessment of Current Status

a. Before the system can be improved, it is important to know what currently exists. For this reason it is essential to conduct an inventory of all the communications/information system equipment presently on the installation.

b. The scope of military communications/information systems is vast. It covers the range from outer space to deep beneath the earth. Figure 2-2 shows the full extent of the communications/information system environments. The classification schemes shown in Figure 2-2 may be used to develop an outline for structuring a comprehensive survey of communications/information resources. Such an outline serves to organize equipment according to four traditional system categories: telephone, radio, video and NAVAIDS. This organized equipment listing constitutes a basic communications inventory giving all the subsystems currently in place at an existing installation. The inventory would have the quantity and type, as well as the location and site requirements of each component, listed under the subsystem involved.

c. It is necessary to define and coordinate the inventory effort between the various communications planning participants. Largely, the planner is seen as taking the lead in this coordination effort. Nevertheless, the information and expertise will often be contained at the major command level (for example, in the Air Force, AFCC is responsible for maintaining all non-contractor maintained communications systems on the installation so that their representative(s) on the installation (the Communications Systems Officer; the Director of Information Management for the Army) will provide most of the required information).

Figure 2-2



Source: Air Force Information Systems Architecture, Vol. 1, 1985

d. Perhaps the type of survey most familiar to the installation engineering community is the site survey. Site surveys are performed for a wide variety of different communications systems such as installing communications cables, HF radio stations, and weather radars. Site surveys for communication systems are usually performed by Communications/Information Systems Command personnel with DEH/BCE engineers as participants. The detailed format of each site survey will differ depending on the specific subsystem(s) involved, but some common elements include:

Site surveys are usually prepared by AFCC (Air Force) or USAIC (Army) personnel.

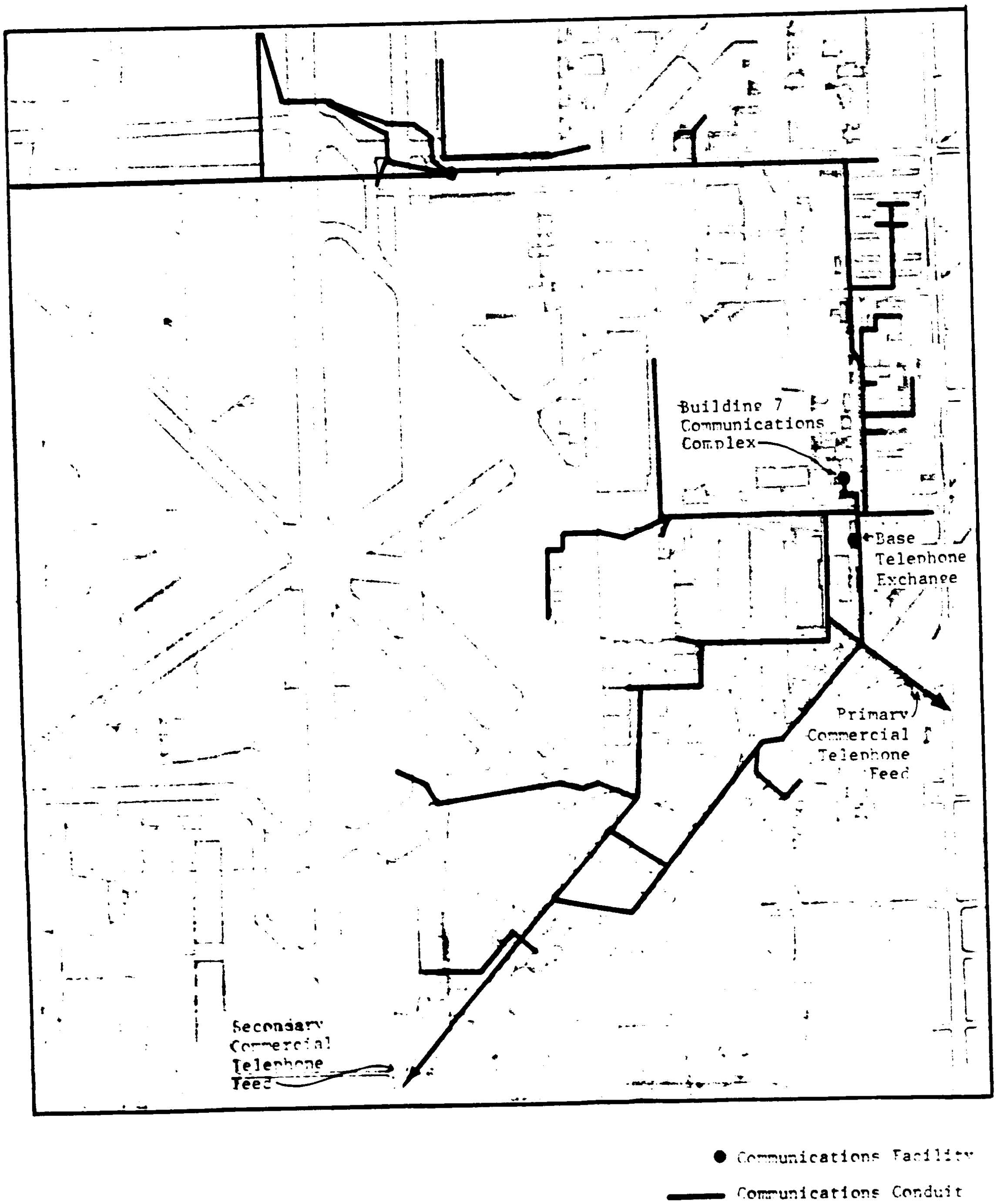
- Site location (coordinates)
- Topography
- Obstruction profiles
- Accessibility
- Site security
- Existing structures
- Existing utilities
- Availability of additional utilities
- Weather and seismic data
- Soil and drainage
- Electromagnetic environment
- Acoustic noise
- Rights-of-way
- Outage history

The Tab H series (Air Force) and/or Existing Conditions Maps (Army) then become vehicles for the display of this information (see Figure 2-3).

e. All potential sources for obtaining data should be explored in order to confirm information from the primary source, or to supplement information not included in other sources, as follows:

Ft. Alpha/Hometown AFB

Figure 2-3



- The initial source of existing communications systems should be the systems maps (communications-computer systems installation records (CSIRS) for the Air Force) available at the installation. These data are probably the most important documentation of existing conditions. The maps contain the type, size and location of all existing systems that are above or below grade at the installation. As-built drawings should also be included as an existing source of communications systems information.

- Often there have been reports and studies that apply to specific communications systems prepared for installations. These are valuable tools for defining conditions and alternatives. A completed report can be an extremely useful tool in the inventory process.

- Public works and power company maps and drawings should be obtained to determine the source and conditions outside the installation. Often, rates and capacities of the utilities are available through these outside sources.

- Field verifications should be made to assure that conditions shown on maps and reports are factual and to reveal information that may not have been shown on the maps that may expand on the existing database.

- Finally, interviews with other technical experts on the installation should be conducted to assure that a complete inventory has been compiled. Shop personnel are also key to identifying communications systems components.

Data sources:
- ***Installation systems maps***
- ***As-built drawings***
- ***Reports and studies***
- ***Public Works maps***
- ***Field-work***
- ***Interviews***

C. IDENTIFYING OPPORTUNITIES AND CONSTRAINTS

2-4. Characteristics

a. Each installation will have characteristics that constrain development or present unique opportunities. The planners and engineers must identify and understand the extent of these constraints and opportunities in developing the Communications Systems Plan. In some cases, the features of the communications systems will have been identified and mapped (Tabs or existing conditions maps). These Tabs/Maps provide the technical basis and input for the various communications systems opportunities and constraints themselves For example, interference from radio signals may necessitate re-siting of a radio antenna facility or congested telephone circuits may result in the need to replace an underground cable plant or convert to fiber optics.

b. In order to prepare a complete evaluation of utilities systems constraints, it will be important to document and consider other planning and environmental features, both existing and proposed, on the installation. For example, environmental factors such as steep slopes, floodplains, hazardous waste sites, unique climatic conditions, may limit the ability to lay underground lines or site an antenna.

2-5. Forecasting

a. Forecasting is a critical element of the communications planning process. The planner and the engineers must work closely in this effort. In most cases, the planner needs to set forth the land development and mission-related requirements for technical interpretation into systems responses by the engineers. The planner derives this information from the land use, transportation and short- and long-range facilities development planning efforts.

b. Forecasting for communications requirements necessitates the consideration of the proposed land use and transportation planning activities on the installation as well as the mission-generated requirements identified by the major command. The operational characteristics of what is existing and working, or what is NOT working, are the backbone for forecasting future demands as they develop. The following questions should be asked:

- Are the communications systems currently in place adequately serving the mission?
- Are current systems capable of accommodating additional development?

- What new construction is planned and are the existing services adequate to support the construction?

c. Typically, communications systems forecasting is done at the major command level using a "systems" approach. Nevertheless, the basic considerations include those of **supply and demand.** These are common terms used to describe the quantity and quality of services offered (supply) and the ability of the consumer to obtain the service (demand).

d. A picture of current conditions (existing supply and demand) will be available as a result of the basic inventory (Figure 2-3). Future needs can then be determined through developing forecasts based on the projected demand (and mission requirements). Forecasting considerations vary by type of system and have direct implications for the development of alternatives. The planners and engineers at the installation level must also be involved in this forecasting process so as to understand the siting and facility implications of the systems.

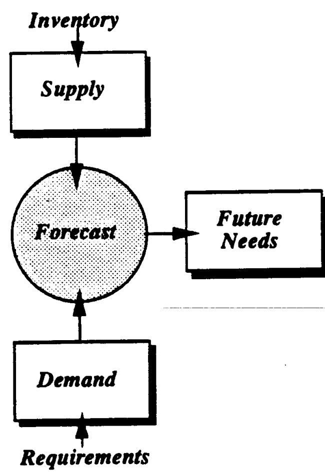


Figure 2-3

D. COMMUNICATIONS SYSTEMS SITING CRITERIA

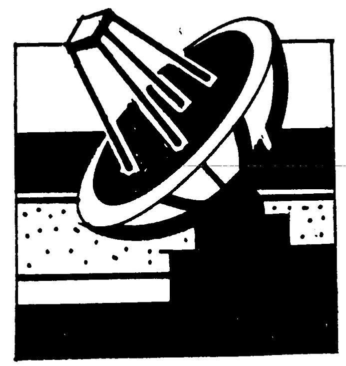
2-6. Planning Parameters

a. Given the complex nature of the various communications systems and facilities, there are a number of specific requirements to ensure both health and safety of installation personnel and the operational effectiveness of the equipment. This information is a critical input to the comprehensive planning process. Land use and transportation/utilities decisions must be based on **a** consideration of these factors. Conversely, the communications systems officer and other technical specialists must be aware of the implications of their siting requests and specifications.

b. The following sections on siting and location of antennas, NAVAIDS/weather, microwave/satellite and video and alarm systems/facilities provide some of the siting criteria and information that goes into the decision-making process of the communications specialists. This information can be helpful to the planners and engineers responsible for preparing and incorporating the communications systems plan into the Plan.

2-7. Antenna Siting and Location

a. The siting and location of single and multiple radio antennas provides an excellent example of the close interaction required between land use planning and communications systems planning. Additional guidance may be obtained from the "Planners Guide to Facilities Layout and Design for the Defense Communications System Physical Plant" (DCA, Volume 1A).

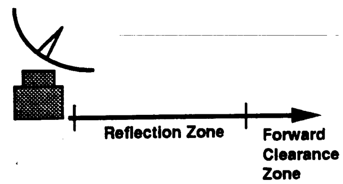


b. High frequency (HF) antennas should be located on reasonably flat ground. Areas with large concentration of rock should be avoided because grading and construction problems are magnified by such terrain and because soil dissimilarities may cause non-uniform ground constraints. Antennas should be sited so that obstructions such as buildings, tall metal structures and mountains are not in the direction of propagation. In general, the obstruction angle for a given wavepath must not exceed 5 degrees (3 degrees is preferred). However, more detailed consideration of siting requirements take into account the Reflection Zone Area and the Forward clearance Zone, as described below:

1) <u>Reflection Zone Area</u>. The reflection zone area is the required area below and in front of a horizontally polarized antenna required for effective formation of the ground reflection lobe. A determination of the length of the reflection zone area in front of an antenna depends upon the antenna height and minimum required radiation or reception angle.- Although the precise determination of a minimum length for the reflection zone involves using a parametric graph, a few typical distances (in feet) are given here as examples:

Departure Angle	Low Antenna (30 Feet High)	High Antenna (100 Feet High)
40°	40 ft.	120 ft.
30°	50 ft.	180 ft.
20°	75 ft.	300 ft.
10°	170 ft.	600 ft.

The surface of this reflection zone should be clear of buildings, antennas, trees, metal fences and other obstructions that could degrade the antenna radiation pattern.



2) Forward clearance Zone. The forward clearance zone is defined as being at the front of the reflection zone and extending out at the same width in degrees as the reflection zone area. Any substantial obstruction in the direction of propagation such as hills, houses and buildings should be avoided.

c. Careful attention must also be given to site selection for transmitting antennas with regard to radiofrequency (RF) radiation hazards. These hazards include:

1) Hazards of electromagnetic radiation to ordnance (HERO)- Siting transmitting antennas in areas at which ordnance materials are located can create a potential hazard.

2) Hazards to fuel (HERF) - The exposure of fuel to RF radiation presents a possible hazard of combustion. Careful attention to design guidelines is a must.

3) Hazards to personnel (HERP) - Extremely powerful transmitting antennas emit enough electromagnetic radiation to injure people who cross in front of the emissions path in close proximity to the source.

Electromagnetic radiation hazards:

- ***HERO: hazards to ordnance***
- ***HERF: hazards to fuel***
- ***HERP: hazards to personnel***

These hazards are described in more detail in Appendix A

d. Site selection must be performed for each of these types of antennas to find a suitable operating location. This is the process of determining whether a particular portion of land can be used satisfactorily as an MF/HF-transmitting or receiving facility. The site selection process involves a long-range, tentative site area selection; tentative site selection using map studies; pre-survey information gathered by teams visiting all candidate sites; and final site surveys in which teams-visit one or more final site selections and gather detailed information on their adequacy. From this information, a decision is made as to the best site to use for the required MF/HF radio communications facility. This selected site is usually the only one that reaches the implementation stage.

e. For reliable reception of weak signals from distant stations, the receiving antennas must be located in an electromagnetically quiet area, relatively isolated from manmade noise. Of the three major sources of RF noise -- galactic, atmospheric, and manmade -- the latter is of chief concern, since it is the one over which some control can be exercised.

f. The main concern In selecting a transmitter site Is the potential for RF Interference with other operations, such as receiving stations and local commercial broadcast reception. This factor, coupled with the large area needed for the antenna park, may demand that the site be remote from populated and industrial areas, or even remote from the installation.

g. The primary consideration in site selection is technical adequacy. Factors such as implementation difficulties, community, fiscal, and auxiliary support requirements; and other logistics problems also must be considered in evaluating possible sites. However, technical suitability must always take priority. Designers usually consider the following:

1) Location with respect to the radio horizon and the probability of maintaining desired transmission take-off angles.

2) Location with respect to existing terminals when facilities are not collocated.

3) Magnitude of initiating and maintaining an adequate logistic support program.

4) Practicality of initiating and maintaining an adequate logistic support program.

5) Feasibility of land acquisition and possible community ramifications.

6) Location with respect to protection against terrorist attack.

h. Detailed information on the site selection process is considered in Military Handbook 413. In this regard, a map study can help in the site investigation process by relating the following information:

1) Preliminary determination of site terrain suitability.

2) Area of land available at a-proposed site location.

3) Take-off angle clearances on projected azimuths.

4) Location of possible sources of electromagnetic interference - high voltage transmission lines, power substations, power generating plants, or existing military or commercial transmitters.

5) Access to, and location of, the support base and transportation facilities.

6) Potential physical restrictions to construction of station facilities and antenna structures.

7) Approximate geographic coordinates of the proposed site.

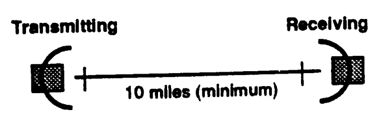
8) Potential community relations implications.

2-8. Receiver vs. Transmitter Sites

a. Receiver Sites. Once established in a quiet area, a receiver site must be protected from encroachment to ensure that it will remain quiet. When possible, this protection should be secured legally. Future construction that may adversely affect communications should be legally prohibited within a zone surrounding the site beyond the station-owned protective corridor. Registry of this encircling land area in accordance with local and state laws to restrict further development is the most desirable way to provide necessary site protection. Alternative methods of ensuring protection are through zoning regulations that limit land development. Such encroachment protection is an on-going process that covers the implementation stage and beyond.

1) The topography and conductance of the area under and immediately in front of the antennas is of importance as they may affect both the efficiency and radiation patterns of the antennas to be used. Open sea surfaces or low, swampy areas are the most nearly perfect reflecting surfaces. Only low vegetation, such as grass and clover, should be in the reflecting area of the antenna field.

2) The potential interference from a high-frequency transmitting station makes it inadvisable to locate the receiver station close to the transmitter station. Although HF reception and transmission are often carried on at the same site, it is not recommended as a general practice since it restricts the frequency bands which can be received successfully. For planning purposes, transmitting and receiving facilities should be separated by a minimum of 10 miles, if possible. High-power radio transmitters also should be avoided since their strong signals may modulate the desired signals by nonlinear response in receiving multicouplers, receiver input stages, etc. Pulsed-type emissions such as radar are particularly likely to cause such interference and most receiving antennas should not be exposed to the direct beam sweep of radar sets.



3) Proposed receiving sites should be checked for low levels of manmade noise by means of listening tests for 72 hours at each site on several high- frequency bands. When a receiving station must be located near industrial or urban areas, the site should be selected so that the principal desired directions of reception are away from the developed area; i.e., the sources of manmade noise are toward the rear of the directive antennas, thus reducing noise pickup.

4) Tables 2-2, 2-3 and 2-4 give criteria for separating a receiver site from other components of a communications station and from interference sources. These data usually are verified by signal and noise measurements at the sites being considered.

b. Transmitter Sites. An extensive electromagnetic noise survey usually is not required for determining transmitter sites. Siting transmitters in an area at which interference will not cause adverse effects is more important than choosing a site with a low ambient noise level.

1) The criteria in Tables 2-2, 2-3 and 2-4 apply to separation of the transmitter site from other facilities as indicated. When transmitting antennas must be oriented with paths crossing, their separation should be such that the convergence point of radiation paths is more than 1,00() feet in front of either antenna. Receiving antennas operating on the same circuit should be separated from each other by 1,00() feet in all directions.

2) The potential interference from a high frequency transmitting station makes it inadvisable to locate the station close to other transmitter stations, receiver stations and ammunition depots. Intermodulation interference may appear in TV and broadcast receivers which are located close to high-power HF transmitting stations. Although this is usually due to inadequate selectivity in the receivers, the public will generally attribute it solely to the transmitter operation. It Is, therefore, desirable to minimize this problem by selecting transmitting station sites which are remote from heavily populated areas If It Is at all practical.

Table 2-2

KF ANTENNA SEPARATION DISTANCE CRITERIA

Activities	Ideal Distance Miles	Minimum Distance Miles
Receiver Site to Service/Secondary Roads	1	1250 ft
Receiver Site to Radar Installation	1	2500 ft
Receiver Site to Major Highways	2	1
Receiver Site to Teletype Facility	2	1
Receiver Site to Overhead Power Lines		
(1) Less than 15 kV	0.5	1250 ft
(2) 15 kV to 100 kV	1	0.5
(3) Greater than 100 kV	2	1
Receiver Site to Inhabited Areas	2	1
Receiver Site to Industrial Areas		
(1) Light Industry	3	1.5
(2) Heavy Industry	5	2.5
Receiver Site to VHF and UHF Transmitter Site	3	15
Receiver Site to Navigational Aid Transmitters	10	5
Receiver Site to HF Transmitter Site		
(1) Under 10 kW	10	5
(2) 10 kW and over	25	15
Receiver Site to VIY and IY Transmitter Site 50	25	
Transmitter Site to Major Highway	1	0.5
Transmitter Site to Inhabited Areas	2	0.5
Transmitter Site to Industrial Areas	2.5	1
Transmitter Site to VHF/UHF Receiver Site	3	1.5
Transmitter Site to Communications Center	5	2
Transmitter Site to Other Transmitter	5	3
Transmitter Site to Airfield	5	3

Table 2-3

VHF/UHF ANTENNA SEPARATION DISTANCE CRITERIA

Facility	Minimum Separation Distance
Service/secondary roads	500 feet
ATC Tower*	1000 feet
Radar	1500 feet
Open Wire High Voltage Power Lines	1500 feet
Industrial Sites	1500 feet
Major Highways	1500 feet
HF Transmitter	One mile
VHF/UHF Transmitters	One mile

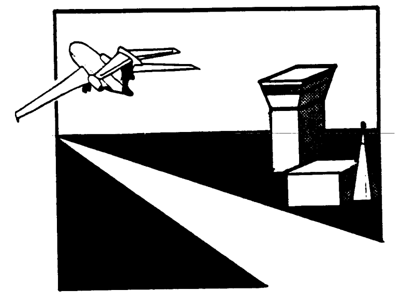
* A VHF/UHF transmitter site should be separated one mile from an ATC Tower.

Table 2-4

TYPICAL ANTENNA SPACING DISTANCES

Rhombic antenna	1000-foot clearance in the direction of transmission; 250-foot clearance at sides.
Log-periodic antenna, horizontal polarization	Same requirements as the rhombic antenna.
Log-periodic antenna, vertical polarization	1000-foot clearance in the direction of transmission; same clearance as for the monopole in all other directions.
Broadband vertical antenna (monopole)	At least one wavelength at lowest operating frequency in all directions.
Dipole antenna	One wavelength clearance in direction of maximum transmission. Dipoles can be placed end-to-end using a common supporting mast, provided they are generally oriented along the same bearing path.

2-9. NAVAIDS and Weather Systems



a. Microwave Landing Systems (MLS). The time reference scanning beam technique has been selected for the proposed international standard microwave landing (descent) guidance to the pilot of an aircraft. While it is possible to have a single integrated MLS unit, most MLS installations are expected to have separate azimuth and elevation units.

1) Location. In most cases, the MLS azimuth and elevation units and marker beacons will be sited in locations comparable to the conventional Instrument Landing System (11-5) installations.

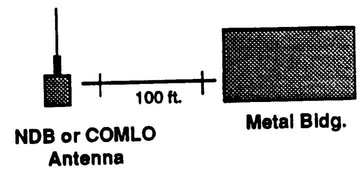
2) Clearances. MLS antenna systems are not as susceptible to signal interference as the conventional 11-5 antenna systems. However, there must be a clear line-of-sight between the MI-S antennas and the approaching aircraft and the departing aircraft when the MI-S signal is used to define a missed approach course.

3) Grading. MLS antenna systems do not use the ground to form the desired course signal. Therefore, the grading for the MLS elevation unit may be limited to that necessary for the antenna unit, the field monitors, a service road and a vehicle parking area. The grading required for an extended runway safety area is usually adequate for the MI-S azimuth facility.

4) Equipment Shelter. The electronic components for the MLS units will. be contained in weatherproof cabinets attached to the antenna supporting structure or m an adjacent shelter.

b. Nondirectional Beacons. A nondirectional beacon (NDB) or compass locator (COMLO) radiates a signal which can be used by pilots to provide them with directional guidance to the transmitting antenna. In some situations, a pole-mounted antenna, roughly 35 feet in height, is adequate. A symmetrical T-antenna, where wires are strung between two 65-foot poles spaced up to 350 feet apart, may be required in other situations.

1) Location. An NDB may be located on or adjacent to the airport. A COMLO may be located at the middle or outer marker beacon site to aid approaching aircraft to intercept the localizer course. In all cases, the NDB or COMLO antenna should be located so It Is at least 100 feet from a metal building, power line, or metal fence.



2) Clearances. Nondirectional beacon antennas located on or adjacent to the airport should not penetrate the approach or transitional controlled airspaces. A nondirectional beacon requires a wire counterpose buried approximately six inches below the surface of the ground or below plow depth of a cultivated field. The size and shape of the counterpoise field will vary with the type of antenna system used.

3) Grading. The nondirectional beacon site should be smooth, level and well drained.

4) Equipment Shelter. The necessary electronic equipment is capable of being housed in the marker beacon shelter for a co-located facility or in a self-contained cabinet for independent units.

c. Tactical Air Navigation System. The tactical air navigation (TACAN) system is the military-developed equivalent of the civilian distance measuring equipment (DME). The TACAN system emits signals that provide pilots with a continuous readout of distance to the facility.

1) Location. A TACAN may be co-located with the ILS localizer to provide distance to runway threshold information when it is impossible or impractical to install marker beacons. TACAN equipment may also be co-located with a TVOR to provide distance to the airport information.

2) Clearances. Site clearances required for the ILS localizer or for a TVOR are generally adequate for TACAN antennas. TACAN antennas should not penetrate the applicable controlled airspaces.

3) General Object Clearances. All objects in the immediate vicinity of the TACAN antenna should be located well below the antenna base. This is particularly important for objects within a 2500 foot radius of the antenna. Objects beyond approximately 10(x) feet distance will only cause shadows, but will not cause substantial errors in any region except the shadow region. Very large buildings, such as hangars, if they are considerably higher than the top of the antenna, may theoretically cause error even when beyond 1000 feet distance, but such error will be localized in the region of specular reflection and usually not be troublesome. When located in a wooded area, it is preferable to have the antenna above the tops of at least the majority of trees, particularly if it is a dense growth. Trees cause an absorption of the signal, which tends to decrease the range. In general, no obstruction beyond 1000 feet will give objectionable reflections; however, shadowing may reduce the low altitude coverage behind such obstruction.

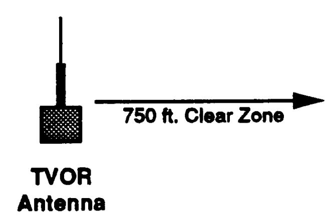
4) Grading. No additional grading is required for the TACAN facility.

5) Equipment Shelter. TACAN electronic equipment is housed within the host NAVAID shelter.

d. Terminal Very High Frequency OmniRange. The terminal very high frequency omnirange (TVOR) is an adaptation of the standard VOR facility to an airport location. The signal provides azimuth information and may be used to develop a nonprecision instrument approach procedure or to otherwise enhance the existing IFR capabilities of an airport. In some situations, a doppler antenna system may be required to overcome problems in electronic performance. Doppler antennas have a 150-foot diameter counterpoise.

1) Location. The TVOR should be located in an area adjacent to the intersection of the principal runways to provide approach guidance to both runways. However, to prevent the TVOR from being an obstruction to aircraft operations, It should be located at least 500 feet from the centerline of any runway and 250 feet from the centerline of any taxiway.

2) Clearances. The TVOR course signal is susceptible to distortions caused by reflections from structures, fences, power lines, or trees.



a) General. All obstructions within 750 feet of the antenna are to be removed except as noted below. Normal crop raising and grazing operations may be permitted in this area, except at mountain-top facilities where antennas are four feet high. In these instances, crop raising and grazing must be restricted within areas immediately adjacent to the antenna.

b) Structures. No structure should be permitted within 750 feet of the antenna, except for buildings located on a slope below the ground level of the antenna so that they are not visible from the antenna, such as the transmitter building at a mountain-top site.

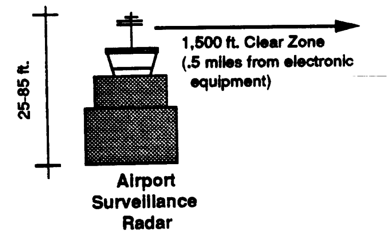
3) Grading. TVOR wave propagation uses both counterpose and ground-reflected signals. Therefore, the surface should be cleared and reasonably smooth with no irregularities such as ravines, ditches, rock outcroppings, embankments, brush, etc. The terrain

should be level for a radius of at least 200 feet. While level ground is preferred, a downward slope not to exceed four percent is permissible between 200 feet and 1,000 feet of the antenna. No upway slope is permitted.

4) Equipment Shelter. All necessary electronic equipment is located within the structure.

e. Airport Surveillance Radar. Airport surveillance radar (ASR) is used to identify and control air traffic generally within 60 nautical miles of the airport. The ASR antenna scans through 360 degrees to present the air traffic controller with location information on all aircraft within line-of-sight range. The actual placement of the ASR antenna is subject to negotiation within the following guidelines:

1) Antenna Location. To minimize transmission cable losses, the ASR-4, -5, -6 and -7 antennas should be within 12,000 feet of the display equipment room. ASR-8 antennas should be within 20,000 feet. **The antenna should be located at least 1,500 feet from any building or object that might cause reflections and at least one-half mile from other electronic equipment.**



2) Antenna Height. The antenna is elevated to obtain the line-of-sight clearances necessary to pick up airborne traffic, but should not violate controlled airspace. The antenna is elevated to be between 25 to 85 feet above ground level.

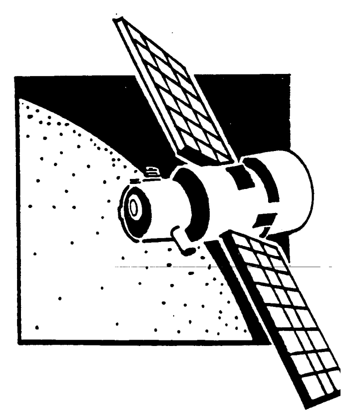
f. Airport Surface Detection Equipment. Airport surface detection equipment (ASDE) is installed at selected airports to overcome the loss of visual observation of surface traffic during periods of reduced visibility. The effective range of an ASDE is approximately three miles.

1) Antenna location. The ASDE antenna operates on a line-of-sight principle and therefore should be placed to have visual coverage of the airport operational areas; i.e., identical to the siting requirement for an ATCT. Therefore, the best location for the ASDE antenna is on the air traffic control tower roof. If circumstances require, the ASDE antenna may be placed on a free-standing tower up to 100 feet (30m) tall located within 6,000 feet of the air traffic control tower.

g. The various aircraft navigation aids described in this Section constitute a complex and overlapping array of land use requirements. It is often necessary to explore several different layout configuration alternatives in order to achieve an optimal design for a given installation. Figure 2-4 gives an example of where some of these NAVAID facilities might be located. The figure also shows the possible location of a satellite earth station (see next section) between two distant locations on earth.

2-10. Microwave and Satellite Systems

a. The satellite recommendations system at an Air Force or Army installation may serve any number of purposes. It may be used to relay long distance non-secure and secure telephone conversations or data transactions. A particularly useful document for siting and location guidance in this area is the DCA Circular "Satellite Communication Station (370-160-3)".

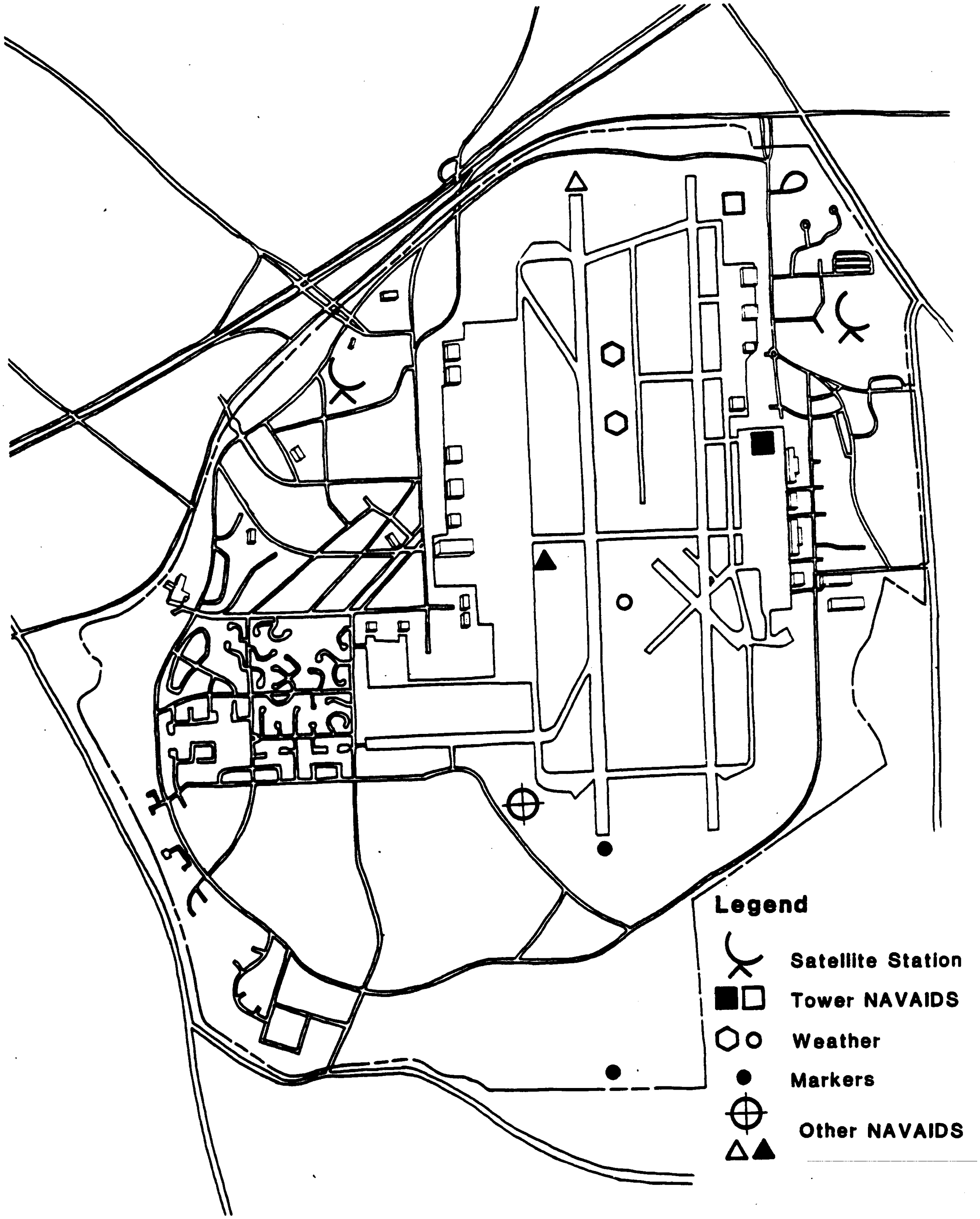


b. General siting requirements for a satellite earth station include:

1) Fairly flat terrain for minimum site preparation.

2) An obstruction clear horizon profile in the direction of the synchronous orbit and above minimum allowable antenna elevation (unobstructed view of the satellite).

Figure 2-4


Legend
Satellite Station
Tower NAVAIDS
Weather
Markers
Other NAVAIDS

3) Sufficient area to accommodate the facilities.

4) A horizon profile, physical separation and antenna directivities providing protection against radio frequency interference (RFI), and, conversely, RFI protection of existing terrestrial services from earth station transmissions.

5) Proximity to a Defense Communications System (DCS) entry station or directly served users.

6) Provisions for survivability, accessibility and logistical support.

7) Acceptable environmental conditions such as an area free from floods or slides with good load bearing soil characteristics.

8) The earth terminal antenna beam requires a minimum path clearance of at least 7 degrees above horizon obstructions throughout the earth terminal's sector of satellite visibility.

c. A satellite earth terminal requires a certain physical environment to operate at maximum efficiency. Some environmental concerns are:

1) Drainage. The site must not be subject to flooding and must be protected against heavy and sustained precipitation by adequate drainage.

2) Soil Characteristics and Tests. The type and bearing strength of the soil is of importance. The requirement that the antenna have a firm foundation is exacting because of the extremely narrow beamwidth. Soils which are characteristically composed of loose sand or volcanic ash require that concrete pads or foundations be constructed to support the antenna base.

d. The survivability of each satellite earth terminal must be considered on an individual basis. If the terminal is supporting only a single user, it may be collocated with and require no greater survivability than that of the user. On the other hand, circumstances may dictate that a terminal serving several users be located at some distance from a prime target area. To improve survivability, two or more terminals comprising an earth station should be separated as widely as local conditions will permit. If possible, the natural protection of high terrain between terminals should be sought so as to minimize collateral damage from a nuclear blast.

e. Ideally, an earth terminal should be located in a relatively large, basin-shaped area with a uniform horizon mask of about 2.5 degrees. This would provide maximum access to satellites in all orbital configurations and RFI protection, assuming that no RFI sources lie within the horizon of the terminal in line- of-sight of the antenna. Even so, such an ideal location can be exposed to RFI by scatter or diffraction modes over obstructions. Therefore, a study and coordination with other users is necessary.

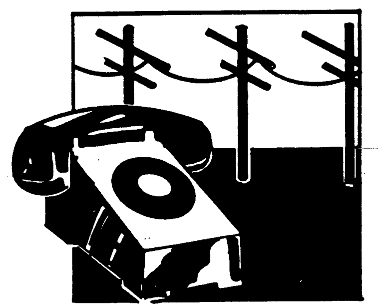
f. A potential radiation hazard to personnel, ordnance and fuels could exist in proximity to the antenna assembly of an earth terminal, which usually employs a disk-type antenna and high-power transmitter. Such a radiation hazard is generally quite small, but it is still necessary to determine whether the hazard exists or not at a given installation. More details on radiation hazards may be found in Appendix A

2-11. Video and Alarm Systems

a. The alarm system at an Air Force or Army installation can range from a simple fire alarm signalling box network to a fully integrated radio-based security, intrusion and fire protection system. The traditional fire detection networks are often operated from telephone cable twisted pairs that lead to a central fire alarm display or console. This system is cumbersome and expensive, since lines are often leased from the local telephone company and used for minimal, although important, information transfer.

b. The fundamental function of most alarm systems is to provide one-way information concerning fire, security, and energy usage to a central display station or console. Modern alarm systems also offer the capability of remotely controlling the process under scrutiny, e.g., initiating local fire suppression, activating security barriers, or controlling local energy consumption. Thus, they afford the opportunity to communicate in both directions so as to exert necessary control in a timely and efficient manner. Figure 2-5 shows some basic alarm and video systems that might be present at a given installation and their possible layout and location. Since fire and security alarm systems often involve line-of-sight components - CCTV, microwave detectors, and radar line-of-sight maps are sometimes helpful in evaluating alternative configurations.

2-12. Telephone Cable Plant



a. The telephone cable plant refers to the network of wires that connects various points on the installation to supply both voice and data telephone service. There are basically four types of telephone cable plant:

1. Underground
2. Aerial
3. Buried
4. Submarine

Elements of the telephone system cable plant are shown in Figures 2-6 and 2-7.

b. Underground Cable Plant. The underground cable plant is that portion of the hard-wired telephone network that is housed in underground conduits. These conduits may be made of concrete, steel, plastic, asbestos, fiber or a variety of other materials. Such conduits usually contain anywhere from 4 to 40 separate ducts through which telephone cables pass. Often these conduits travel under roadways, in which case the typical maximum length of a

Figure 2-5

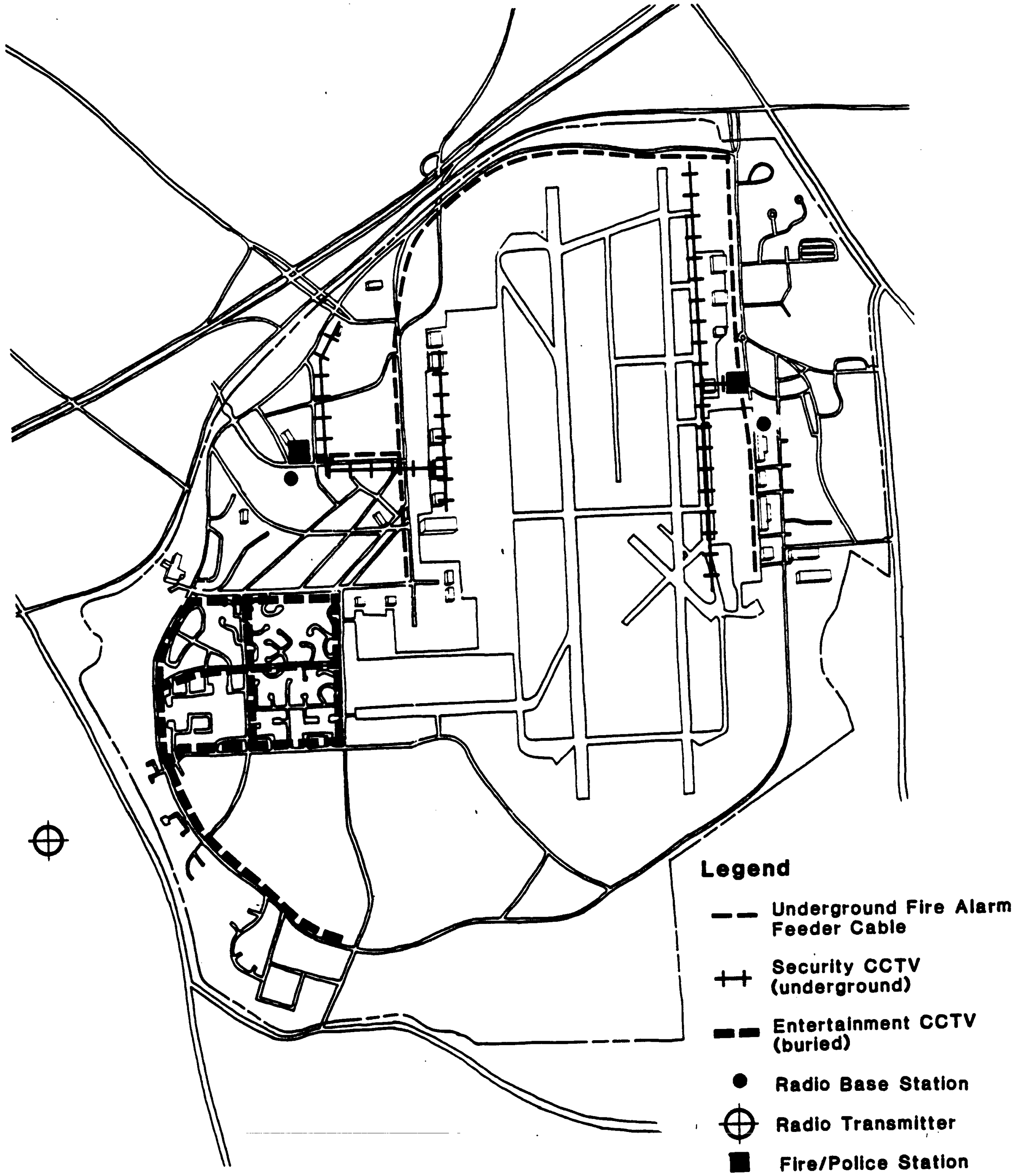
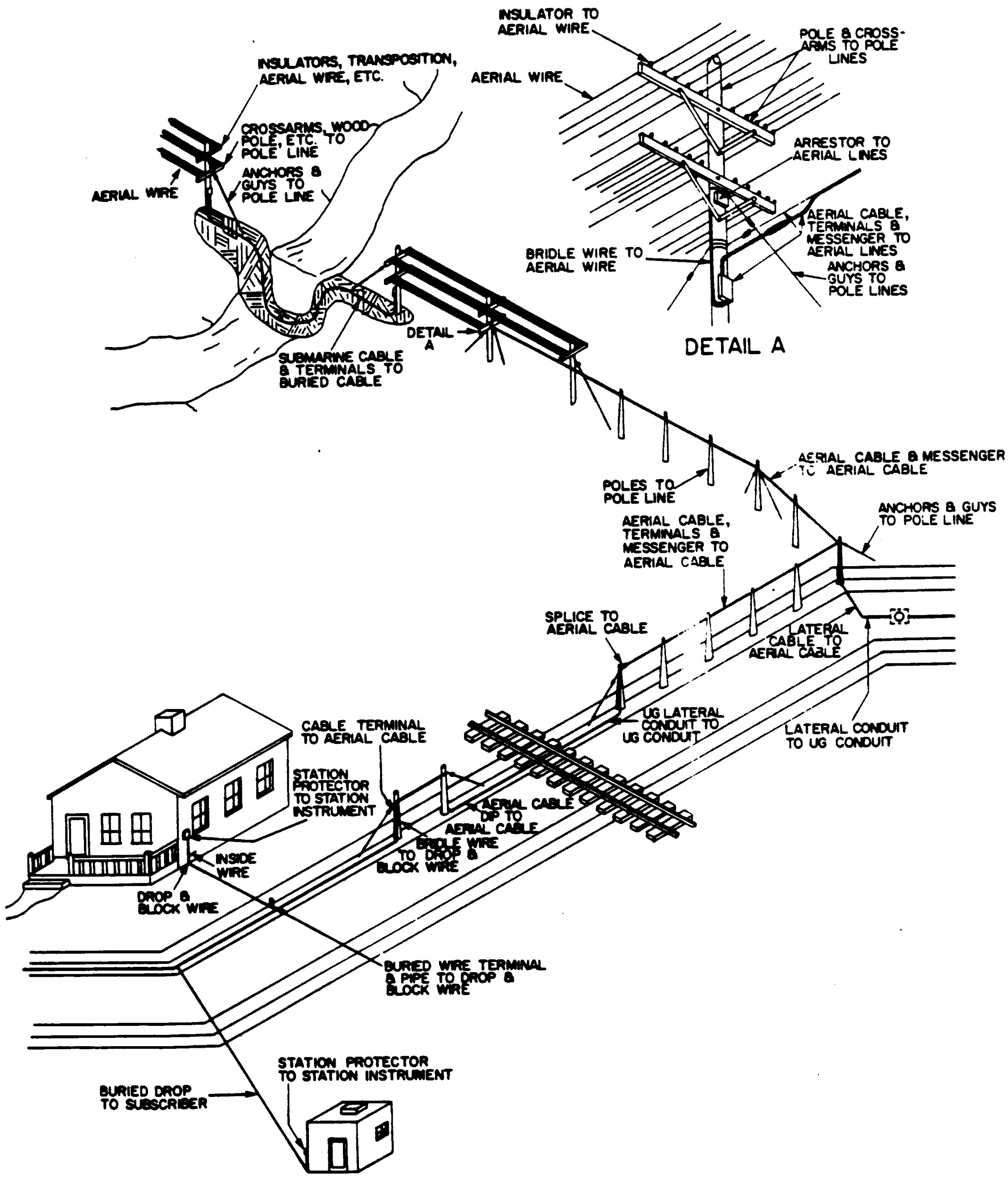
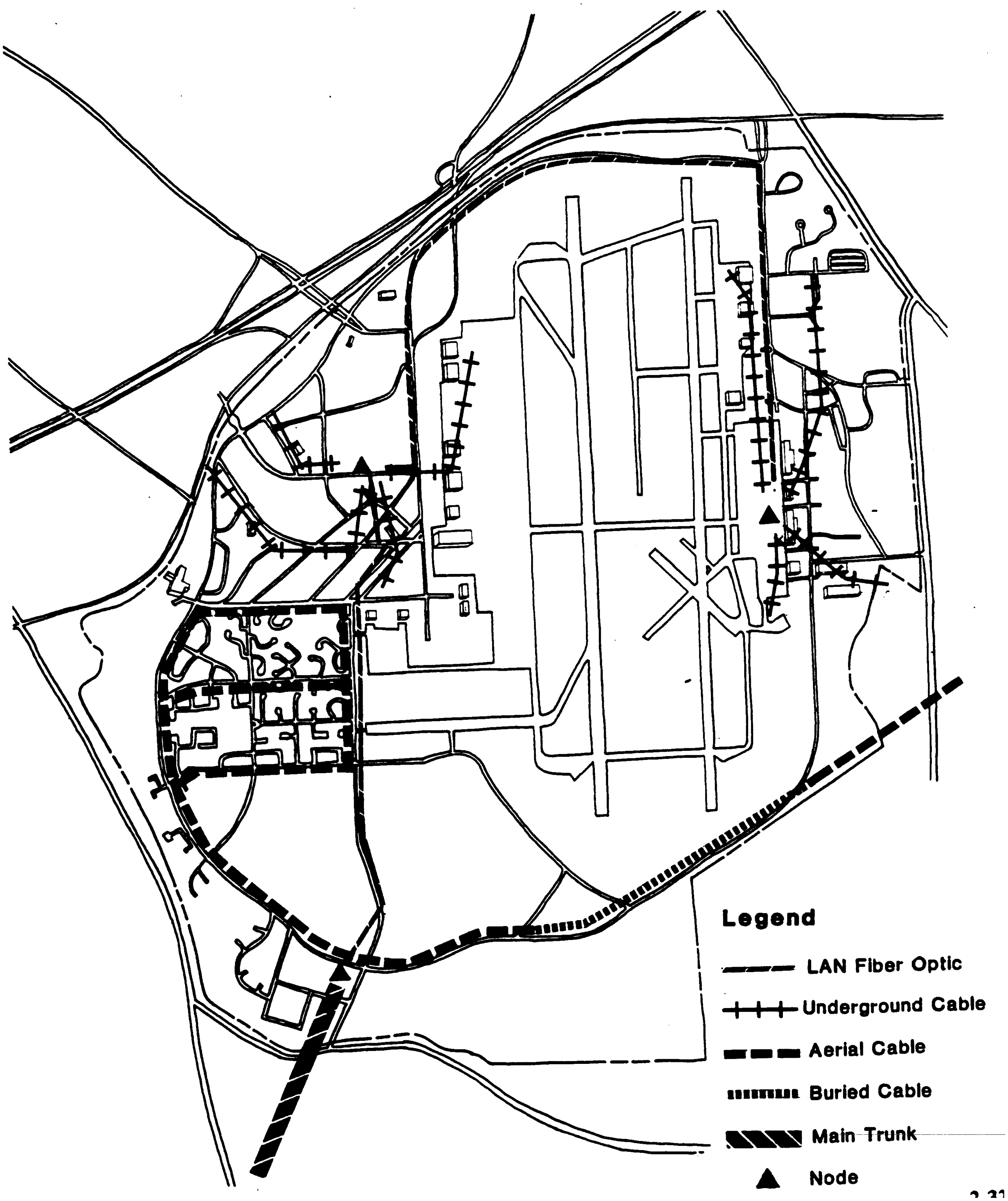

Legend
Underground Fire Alarm Feeder Cable
Security CCTV (underground)
Entertainment CCTV (buried)
Radio Base Station
Radio Transmitter
Fire/Police Station

Figure 2-6



Source: Telecommunications Engineering, Outside Plant Telephone, 1978


Legend
LAN Fiber Optic
Underground Cable
Aerial Cable
Buried Cable
Main Trunk
Node

straight run should not exceed approximately 1,000 feet between manholes. Because of the difficulty of pulling wires, conduit lengths must be much shorter if they involve substantial bends. Special considerations also apply to cases where an underground telephone cable passes under a railroad.

c. Aerial Cable Plant. The aerial cable plant is that portion of the hard-wired telephone network that passes through the air, usually suspended from telephone poles. The general rules for selecting a pole line route are:

- The route should be reasonably straight to produce the most economical span lengths and to reduce the need for guying the poles.

- The route should be reasonably clear of trees, especially if the line is to carry open wires.

- The line should be placed along one side of a road to avoid road crossings as much as possible.

- Routing shall be selected so that future extensions may be made at a minimum cost.

- Extra long spans should be avoided as much as possible.

- Crossing high-tension lines and other electric power lines should be avoided.

- Aerial cable plants should not be located in the vicinity of airport runways.

In addition, aerial cables and their poles must be designed to handle differing amounts of ice loading. The aerial cable plant must also be designed to have various horizontal and vertical clearances from nearby objects. Some of these recommended minimum clearances are given in Tables 2-5 and 2-6.

d. Buried Cable Plant. The buried cable plant is that portion of the hard-wired telephone network where the cable is buried directly in the ground without rigid conduits. In this case a trench is dug in the ground and telephones cables with special protective coatings are laid directly in the trench. At certain points along the path of a buried telephone cable, small above-ground enclosures are required to accommodate splices, terminations, cross-connects, loading coils, etc. These enclosures should be located at the following places:

- subscriber distribution points;
- junction splices or tapes points;
- railroad, pavement, pipeline and other crossings;
- load points;
- build-out capacitor points; and
- as close to fences and other physical barriers as possible.

Special considerations must also be given whenever a buried cable crosses a railroad, a paved street or highway or a pipeline. Railroad crossings are generally made by using steel pipe that is buried a certain depth below the tracks. Roads and pipelines are generally crossed without the need for conduit or piping, but strict minimum depth and separation distances must be met. In all cases, responsible company or government officials should be consulted concerning required clearances.

Table 2-5

MINIMUM HORIZONTAL CLEARANCES FOR TELEPHONE POLES

Object	Distance (ft)
Fire Hydrant	3
Railroad Tracks	Falling Distance of Pole
Rail Siding	12
Curb Line (street side)	0.5
Power Lines	5

Table 2-6

MINIMUM VERTICAL CLEARANCES FOR TELEPHONE LINES

Object	Distance (ft)
Crossing Over:	
Driveways	10
Alleys	15
Walkways	8
Railroads	27
Streets and Roads	18
Adjacent to:	
Urban Road	18
Rural Roads	14
Rural Roads without loaded vehicles	13
Alleys	15
Walkways (pedestrians only)	8

e. Submarine Cable Plant. The submarine cable plant is that portion of the telephone network that must traverse under water. Both submarine and aerial crossings of large expanses of water should be avoided as much as possible. Whenever it is necessary to run telephone cables under bodies of water, special attention must be paid to route selection. In the case of telephone cables under navigable waterways, written permission must be obtained from the U.S. Army Corps of Engineers. Accurate water depth information should be determined from U.S. Coast and Geodetics Surveys or from depth soundings made along the projected cable path. The crossing should enter the waterway at right angles and proceed across the water in as direct a line as possible. However, in the case of waterways with sandy or muddy bottoms, a slight upstream curvature can sometimes be beneficial to allow for cable sinking or movement. Routes over rocks and sudden changes in depth should be avoided, as should locations near piers or congested water traffic, or where the water current is typically greater than 5 knots. Usually submarine telephone cables are laid directly on the bottom of the waterway. However, in order to protect from dredging, debris, ice or other hazards, cables are sometimes placed in a trench at least 5 feet below the ultimate channel depth, or they may be carried in steel pipes.

3

Alternatives Evaluation

CHAPTER 3

ALTERNATIVES ANALYSIS

A. ALTERNATIVE PLAN DEVELOPMENT

3-1. Selecting Alternatives

a. At this stage of the planning process, the current and future communications needs of the installation are evident. The next step is to examine appropriate ways to meet these needs. Except in rare cases where only one action is possible, the communications specialists must define different alternative actions (Figure 3-1). This requires both creativity and the ability to evaluate proposed ideas at an early stage, so that major effort is not wasted on completely unrealistic alternatives. The selected alternatives then become the focus of the plan evaluation.

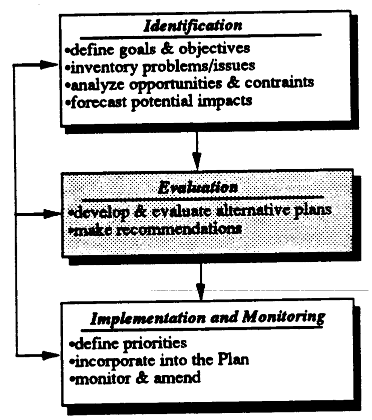


Figure 3-1

b. Land use and communications systems alternatives must be developed concurrently. Each possible land use alternative may suggest one or more communication system configurations, which, in turn, may lead to a re-examination of the proposed land use concept. These land uses may then result in the need to revise the future communications forecasts and requirement. In practice, the planner and installation decision- makers must decide on a reasonable blend of land use and communications systems alternatives.

3-2. Specific Communications Alternatives

a. The term "communications systems alternative" refers to a combination of actions that may involve communications traffic control, alternate routing, network configuration changes, network hierarchy adjustments, and special on-installation actions relating to installation information access and security, movements of critical information, and other specific needs. It is not enough to merely look at one alternative if there are others that could provide equal or better communications service.

b. Communications alternatives can be categorized according to time and cost requirements. Generally, short-term actions to meet current needs would be lower in cost, while major changes requiring more time to implement would tend to cost more. Since most installations already have established communication systems, the need for planning changes several years into the future may be the exception rather than the rule. Short-term and/or lower-cost alternatives will fit many of the installation needs, as long as these alternatives are consistent with the installation's longer term development objectives and overall communications configuration. Certain downward-directed initiatives may prove to be an exception, however. Sometimes entirely new systems are mandated from above. Nevertheless, usually the emphasis is placed on improving the use of existing facilities as opposed to developing totally new systems.

c. Early in the planning process the communications specialists will typically select the most feasible communications alternatives from among a range of alternatives. In this way, attention can be focused on the most cost-effective alternatives. Because entirely new communications systems tend to be exceedingly complex and very costly, the preferred approach is evolutionary rather than revolutionary. Principles of Evolutionary Development are endorsed by both the Air Force (AFP 700-50, Volume I) and the Army (AR 25-1).

3-3. Refining the Alternatives

a. The structure of the Communications Systems Planning Process also leads to the natural generation and evaluation of increasingly detailed and technical alternatives as the process unfolds. Let us take the planning and siting of a new radio antenna facility at a given installation as an example. initially the planner evaluates the best way to accommodate the new radio antenna facility on the installation. Alternative sites are developed upon the Base/Installation Comprehensive Plan (the Plan) and, in particular, the I-and Use Plan, Natural Resources Plan, and any other technical information that is available.

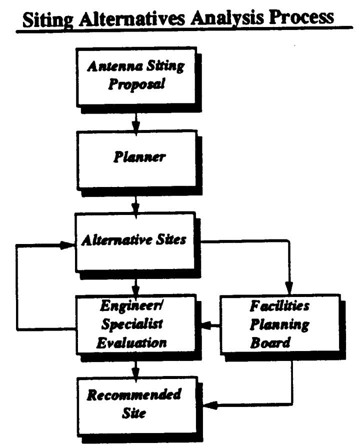


Figure 3-2

b. After these sites have been selected and evaluated in a preliminary way, an engineer with the particular antenna design expertise that is required will be called in from the AFCC, USAISC or another technically involved group. This antenna specialist will evaluate the preliminary slate of alternatives and probably eliminate some on the basis of technical concerns unique to that particular kind of antenna and its operation. The specialist may also generate his/her own new alternative sites and configurations, again based upon special technical concerns. These new alternatives may be entirely different from the preliminary ones suggested by the planner. For an exceedingly complex antenna farm, this process may be repeated several times with several different antenna experts, each bringing unique technical expertise to the planning process. All branches of the military use a similar model for involving highly specialized communications technical personnel at appropriate stages in the communications planning process.

B. EVALUATION AND RECOMMENDATION

3-4. Factors to Be Considered

a. The adoption of a communications plan should occur after a process of designing and testing several alternative plans. The evaluation phase is an examination of each communications system alternative and how well it provides for changes in land use (as reflected in the Land Use Plan) and meets the future mission and installation needs.

b. It is important to recognize that there are no absolutes in resolving problems, only compromise that provide the best balance between the essential factors of mission accomplishment, the installation's goals and objectives, and the protection and preservation of mission capability life and property. All must be considered in the context of the complete comprehensive planning efforts on the installation.

c. A systematic approach should be used for evaluation and the process should involve the planner, the engineer and the communications systems engineer; again where the engineer/specialist applies his/her systems knowledge and experience and the planner controls for consistency in land use, policy and mission requirements.

3-5. Recommendation of Alternative(s)

a. After completing the evaluation phase, the planner and engineer must come to a consensus regarding recommendations on the preferred communications systems plan alternative(s). Complex problems may require solutions that involve multiple actions and projects.

b. The Communications Systems Plan recommendations must reflect sensitivity and knowledge of the communications needs/demands of the community surrounding the installation. For example, a recommendation to expand the capacity of the telephone system on the installation may require actions for off-installation supply lines. likewise, the recommendation for new high frequency antenna system on the installation could affect the television/radio reception of the adjoining community. In each case, cooperation with civilian agencies is necessary to ensure that the recommendations can be incorporated/reflected in the work program for those agencies.

4

Implementation & Monitoring

CHAPTER 4

IMPLEMENTATION AND MONITORING

A. IMPLEMENTATION

4-1. The Final Planning Phase

a. The implementation process includes the prioritization, timing and methods necessary to accomplish Communications Systems Plan recommendations (Figure 4-1). Implementation is the result of matching the recommended projects with available funds to accomplish both the short and long-range objectives of the installation.

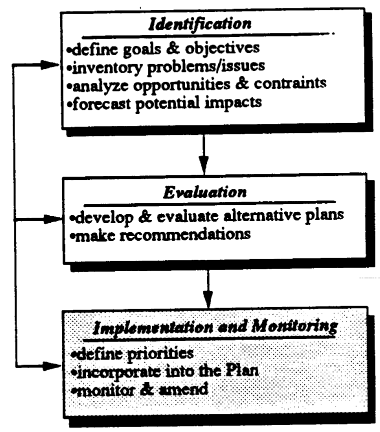


Figure 4-1

b. It is important to note that communications systems planning for an installation is not an independent task but must be part of the overall comprehensive planning process and feedback loop. As discussed throughout this bulletin/manual, all communications systems planning must be part of and consistent with planning in the other components of the Plan, particularly the land use, utilities and transportation plans. The implementation of other plan components and the communications systems plan component must be coordinated.

B. PRIORITIZATION

4-2. Establishing Priorities

a. Prioritization is the process used to determine a ranking of recommended projects in the Long-Range Facilities Development Plan. It also establishes a schedule and costing plan for inclusion of short-range recommendations in the Capital Improvements Program (CIP). Prioritization consists of three elements:

- Installation goals
- Long range development
- Planned projects

The goals and related policies help match project priorities with available funds to produce an effective program of improvements.

b. At this point in the process, the programmers on the installation will have an important role. Their efforts include making the appropriate presentations and submittals to the Facilities Board/Installation Planning Board.

c. The priority ranking factors the relative effects of the specific communications project recommendations on other projects on the installation. As the land use component of the Plan often drives the implementation of other plan components, including communications improvements, the engineers and planner should recommend that those recommendations that have a more direct effect on the implementation of land use plan elements receive priority. Recommendations that could disrupt the timing or feasibility of planned land use development should receive a lower ranking than those that are fully supportive of it. It will be advantageous to have worked closely with the development of other elements of the Plan because the projects are prioritized together.

4-3. Funding Prioritization

a. The programmer considers various funding sources for desirable projects. The typical funding arrangements include the Military Construction Program/Authorization (MILCON). Line items for communications systems improvements can be included with MILCON-funded projects. These projects tend to receive low priorities but should be explored for major actions.

Funding sources:
- ***Separate MILCON project***
- ***Included in facility MILCON project***
- ***O & M funding***

b. The normal DD 1391 process would be used. Eligible projects can include installation-wide upgrading of the utilities systems or small projects limited to a specific upgrade of a single utility. Operations and Maintenance (O&M) Funding is available for utility system improvements up to the installation's funding limits. Requests for projects to be funded under the higher Major Command O&M limits are also possible.

c. As funding is usually insufficient to meet all the needs and, in nearly every case, it is physically impossible tg undertake all work simultaneously, recommendations must be prioritized. The programmer, with assistance from the planner, prepares a prioritized list of projects, keeping in mind the cost of the project, its timing, and its effect on other installation projects.

d. One of the prime objectives in programming projects is to obtain the greatest benefits from the available funds. Cost often is the leading factor for setting utilities priorities. Generally, direct costs and short-term values are considered in programming priorities.

e. Timing also plays an important part m setting priorities. Short-term recommendations typically receive higher ranking than those that will take longer to implement or that satisfy only future needs. As timing varies among projects, projects should ranked separately within certain time periods, such as immediately, within the next five years, five to ten years, ten to twenty years. This format is compatible with the needs of the five-year CIP. Although specific project scheduling is done only for the five-year CIP, the Communications Systems Plan recommendations should attempt to relate long-term objectives to those addressed in the short-term.

4-4. Coordination

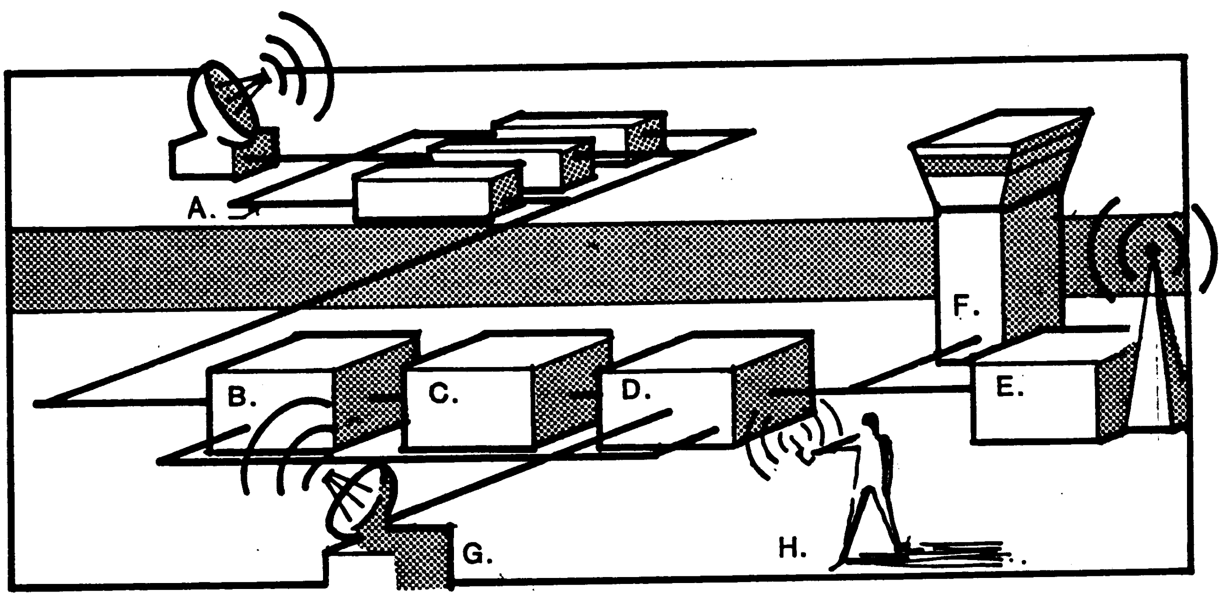
Coordination with civilian agencies is essential for communications systems which tie into off-installation systems.

a. It is essential to coordinate with civilian agencies responsible for implementing communications systems outside the installation. Most communities prepare capital improvement programs for five-year periods. To the extent possible, the installation's approach should be compatible with those of the outside projects. Adequate communications services, such as the telephone, are critical to the military mission. Therefore, interaction with the appropriate civilian agencies to coordinate the prioritization of their projects to be compatible with those expected to occur within the installation is necessary. For on-site improvements, define the responsibilities among the responsive functions such as installation civil engineering, information security and electrical engineering. Also coordinate with civilian agencies responsible for implementing communications improvements outside of the installation. Typically, a 60-day review period for State and Federal agency approval is required if off-site communities are affected.

b. Figure 4-2 displays some of the typical on-site communications facilities that might be found at a given military installation. As can be seen in the figure, runways, roads, towers and buildings all play a role in communications system layout. Any change in these facilities occurring during the implementation phase must be taken into account and adjusted for. Geography and topography are also important factors. close coordination is needed with off-site organizations and personnel to ensure proper connectivity to the public telephone and telegraph networks, as well as compatible use of radio frequency and microwave communication media, so as not to interfere with or be interfered by other commercial, public safety, or international radio users. During the implementation and monitoring phase, tests should be made to ensure that no unexpected interference has occurred. If it has, corrective actions may have to be taken.

Communications Environment

Figure 4-2



- A Local Area Network
- B Wing / Base Ops Center
- C Information Center
- D Central Telephone Exchange
- E Air/ Ground Radio
- F Control Tower
- G Microwave Terminal
- H Intrabase Radio

Source: Air Force Information Systems Architecture, Vol. 1, 1985

c. Good communications access to and from the installation is critical to mission effectiveness. Therefore, interact with the appropriate civilian agencies and communications vendors to implement needed improvements to off-installation connectivity. In turn, encourage civilian agencies to prioritize communications improvements and development proposals to be compatible with land use or communications changes expected to occur on the installation. Once again, coordination between the command-level communications/electrical engineering function and the installation level civil engineering functions is essential.

C. MONITORING

4-5. Using the Communications Systems Plan

a. The communications planning process also includes the means to monitor conditions after implementation. Monitoring is an ongoing activity to ensure that the improvements are installed in accordance with the Communications Systems Plan, perform as expected, and are adjusted as necessary. As the communications systems Tabs/Maps are largely computerized, updating and revising them is facilitated.

b. One characteristic of communication plans is that the analysis performed this year may be obsolete next year. Obsolescence of the communications component of the Plan is inevitable owing to changing missions of the installation, revisions to goals and objectives, rapidly advancing technology, or changes in funding availability. Therefore, monitoring the communications conditions and land use changes on the installation, and maintaining contact with appropriate civilian agencies is essential. Further, to the extent possible, the conditions of the installation should also be monitored to make sure that the Plan is still is harmony with actions being taken in the community.

c. Actual progress on specific communications projects should be compared with the scheduled progress as shown in the installation CIP. When monitoring indicates serious slippages in a project's implementation schedule, the program should be modified as necessary.

4-6. Plan Updates

a. The communications systems planning process must be accompanied by a corresponding effort to keep it relevant. As new facilities are constructed and improvements occur, the Utilities Systems Plan will have to be modified to reflect these changes.

Plan update required because of:

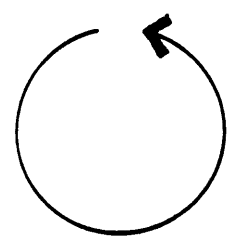
- ***Facility improvements***
- ***Mission changes***
- ***Advances in technology***

b. Changes in mission can have a significant impact in terms of the installation's facilities and supporting systems. Expansion of an installation's mission and the corresponding assignment of substantial numbers of new military personnel to an installation will place significant new demands on or changes to facilities and the communications systems that serve them.

c. Advances in technology the evolution of the surrounding region, and the accumulation of new information can all have impacts that must be accounted for in the Communications Systems Plan.

d. It is extremely important that the communications systems planning process include a feedback loop so that new information can be continually incorporated. The acquisition of fresh data may require planners to reformulate some of the original goals and objectives in order to more accurately encompass the needs of the changing installation community. Adopting a particular policy or program called for by the Communications Systems Plan may lead to the discovery of unanticipated adverse impacts that have to be corrected, (either within the Communications Systems Plan itself or within another Plan component) or it may turn out that a particular recommendation has created an unanticipated opportunity for improving the installation's quality of life.

Feedback Loop



Appendix

APPENDIX A

ELECTRO-MAGNETICRADlATION HAZARDS (EMRH)

A.1 Introduction

Electromagnetic Radiation Hazards (EMRH) could exist in the vicinity of any source of electromagnetic radiation. Thus, the class of potentially dangerous objects includes all types of antennas, as well as many other electrical and electronic devices. Our environment is constantly bathed in invisible electromagnetic radiation from radio, television, and radar transmitters, power lines, microwave ovens, etc. In most cases, the radiation source levels are sufficiently low or the radiation source is sufficiently far away that this ubiquitous electromagnetic background is not harmful to people or property. However, whenever a person or a flammable or explosive object gets in the direct path of certain high-intensity antenna systems found on or near military installations, a potentially dangerous situation could exist. The three most prominent types of Electromagnetic Radiation Hazards (BMRH) are:

1. Personnel Hazards,
2. Fuel Hazards, and
3. Electro-Explosive Device (BED) Hazards.

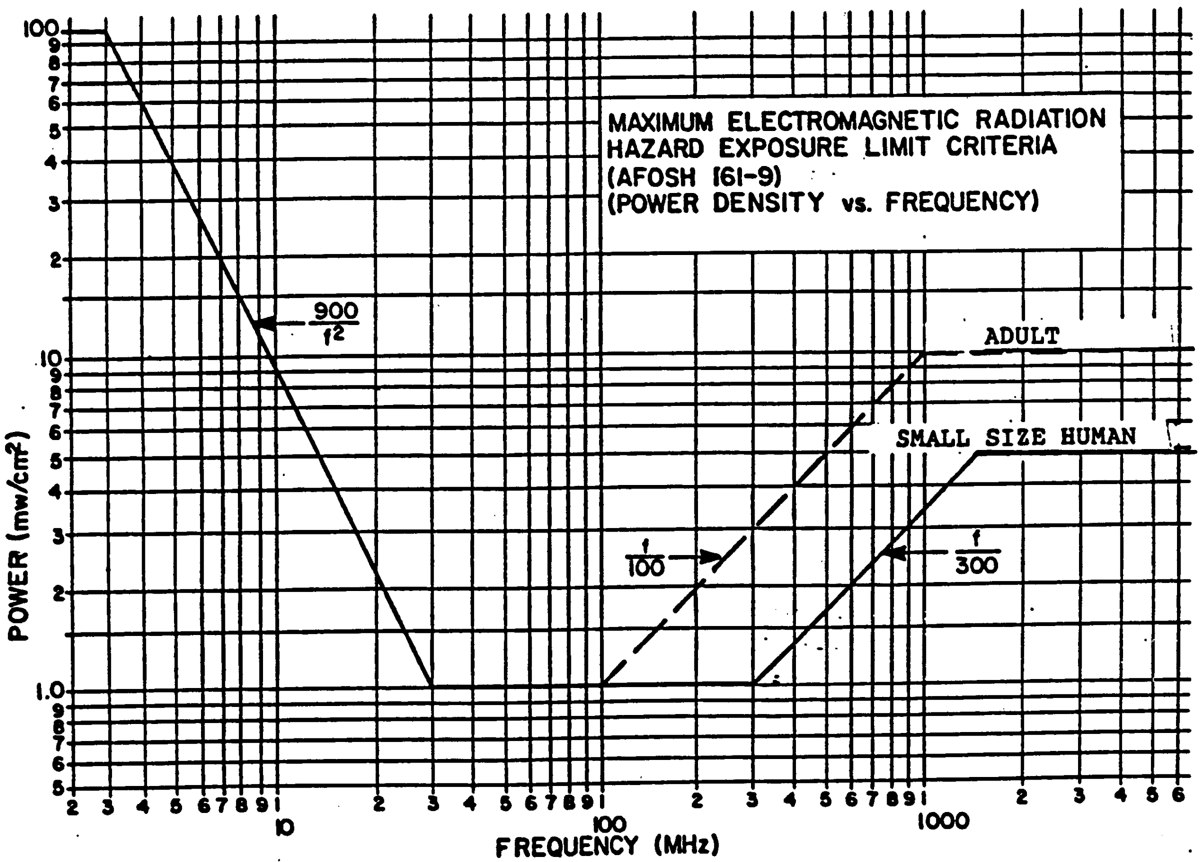
A.2 Personnel Hazards

People have a finite tolerance for electromagnetic radiation impinging on the body. The fundamentals problem is that certain combinations of high-power and/or high frequency electromagnetic radiation are readily absorbed by the body tissue. This absorption of energy heats the internal body tissue, in the same way that a microwave oven cooks a piece of meat. Sufficient heating of body tissue in this manner can be dangerous. Moreover, some body tissue is more sensitive than other tissues to electromagnetic radiation exposure. Safe exposure levels are usually determined on the basis of the most sensitive tissue. In addition, certain electronic medical aids like heart pacemakers or other implanted devices may be adversely affected by these intrusive electromagnetic penetrations. They may either act erratically or cease to function altogether.

The maximum electromagnetic radiation limits for the human body strongly depend upon the frequency of the radiating source. There is a frequency region between 30 and 300 MHz where personnel tolerance for electromagnetic radiation is at a minimum, representing a permissible power density of about 1 milliwatt per square centimeter (1.0 mw/cm^2). This is the most dangerous frequency region. However, electromagnetic radiation of any frequency, if sufficiently intense, can also be harmful. Figure A-1 portrays electromagnetic radiation hazard maximum exposure limit criteria for personnel. It shows the maximum permissible power density (mw/cm^2) that a person can tolerate as a function of the (carrier) frequency of the radiation source ~n megahertz (MHz). In most practical cases, this radiation source is an antenna. For frequencies above 100 MHz, the maximum permissible radiation exposure depends upon the height of the person. Adults are defined as any persons over 55 inches tall, whereas small size humans are defined as any persons below 55 inches tall. As can be seen from Figure A-1, small size humans are more sensitive than adults to electromagnetic radiation hazards. Also evident in the figure is an overall maximum hazard exposure limit of 100 mw/cm^2 no matter what the frequency.

Maximum Personnel Exposure Limit Criteria

Figure A-1



f: frequency in MHz

Source: Air Force Communications Command

In the case of the Air Force, the USAF Occupational and Environmental Health Laboratory (OEHL) provides both consulting and measurement services to base installations concerning personnel hazards. These services cover the health effects of all electromagnetic radiation sources, both radio-frequency and x-ray, and are available in the field through the Base Bioenvironmental Engineer (BEE). More information on these services may be found in AFOSH Standard 161-9.

A.3 Fuel Hazards

All metal objects located in a field of electromagnetic radiation have the potential to serve as a receiving antenna system. Depending upon the strength and direction of the surrounding electromagnetic field, the geometry of the metal object and the grounding conditions, certain metal objects will act as quite effective antennas. Such metal objects may be quite effective as capturing electromagnetic energy from the atmosphere and converting it into electrical currents in the object itself. These currents could possibly produce electrical arcing across poorly welded seams or from rough edges of metal. If they occur in certain places, arcs of this sort could potentially ignite gasoline, aviation fuel or other flammable vapors. Such fuel hazards are particularly severe in equipment associated with aircraft refueling operations. Therefore, special care must be taken when refueling airplanes or vehicles in the vicinity of emitters of strong electromagnetic radiation.

As concerns the Air Force, AFOSH Standard 127-38 establishes the maximum safe peak power density for electromagnetic radiation in the vicinity of fuels. This level has been set at 5 Watts per square centimeter (5 W/cm^2). The Aeronautical System Division (ASD) of the Air Force Systems Command (AFSC) provides consulting services to field installations concerning electromagnetic radiation hazards to fuels.

A.4 EIectro-ExpIosive Device (EED) Hazards

The same general principle that applies to fuel hazards operates in the case of certain munitions and explosive devices. The metallic portion of the explosive device serves as an antenna to transform the surrounding electromagnetic radiation into electrical currents flowing through the explosive device itself. In the case of Electro-Explosive Devices (EEDs), which are electrically ignited, these electrical currents could potentially detonate the device depending upon the electro-magnetic radiation environment and the characteristics and location of the EED. Such EEDs include blasting caps, squibs and igniters. Furthermore, the same EED is differentially sensitive to radio-frequency and x-ray electromagnetic radiation depending upon how it is stored. Thus, there are several different categories of maximum safe levels for BED exposure to electromagnetic radiation:

A. Unknown (worst case),
B. Exposed EEDs,
C. EEDs in a metal container,
D. EEDs in a non-metal container,
E. EEDs in parked or taxiing aircraft,
F. EEDs in aircraft in flight or in cargo aircraft, and
G. Leadless BEDs.

As concerns the Air Force, Regulation AFR 127-100 gives the maximum permissible average power density levels of EEDs. Not only do the levels differ according to how the EEDs arc stored, but also in some cases depending upon the frequency of the electromagnetic radiation impinging upon the EEDs. In the worst case of unknown EED conditions, the maximum permissible level of electromagnetic radiation for EEDs is 0.01 Watts per square meter (0.01 W/m^2). Depending upon specific conditions, the maximum permissible level can rise to 100 W/m^2 or even 10k W/m^2, if the BEDs are stored in certain ways. In any case, care should be taken when locating BEDs or equipment containing BEDs in strong electromagnetic fields. As in the case of fuel hazards, the Aeronautical System Division (ASD) of the Air Force Systems Command (AFSC) can provide consulting services on electromagnetic radiation hazards to BEDs.

A.5 Documentation Requirements

The status of EMRH should be documented at each installation. For the Air Force, if there is no EMRH associated with a given device, this fact may be documented by a letter from the Base Bioenvironmental Engineer (BEE), the Occupational and Environmental Health Laboratory (OBHL) or the Air Force Communications Command (AFCC). If a hazard does exist, either a Radio Frequency Hazard Study or a Radio Frequency Hazard Survey should be conducted and the results documented in a report.

A.6 Radio Frequency Study

A Radio Frequency Study is a theoretical evaluation of potential EMRH problems with a certain type of electronic system, usually an antenna. Such a study considers the possible impact of this device on personnel, fuels and BEDs from calculations based upon theory of operation, knowledge of operating parameters, antenna height, previous measurements and simplified mathematical models. To the degree possible, unique siting and environmental considerations should also be taken into account, but they are often difficult to fit into a simplified theoretical study. Such RF studies are, nevertheless, quite useful as a first approximation of the sort of possible BMRH problems that might exist. For fuel and BED hazards these types of theoretical studies are often sufficient as long as they do not indicate any significant danger (with an adequate margin of safety), and as long as they do not unreasonably curtail efficient operations at the base or installation.

The report that is written after such a theoretical study has been conducted should point out any potential hazards during "normal operations" of the equipment and during a "worst case" scenario. An example of this distinction would be the establishment of safe distances from a powerful rotating radar antenna in order to eliminate fuel hazards. The normal operating exposure to electromagnetic radiation for a given airplane would be extremely brief, since the rotating antenna beam only points in any given direction for a brief instant. An airplane refueling operation may be perfectly safe in reasonably close proximity to such an antenna under "normal operation conditions." However, under "worst case conditions," where the antenna has stopped rotating for some reason and is pointing directly at the airplane, a much greater safe distance may be required. In the absence of any further information, only the "worst case" separation distances should be used by facility planners in layout out base configurations and siting new antenna systems.

A.7. Radio Frequency Survey

Any device that emits enough electromagnetic radiation to pose a potential hazard to personnel must be evaluated by means of a Radio Frequency Survey. An RF Survey consists of a carefully planned series of measurements of the actual amount of electromagnetic radiation emitted by a given system in its natural setting during typical operation. An RF Survey is by far the most accurate and precise way to determine the possible impact of a given electronic system and to establish minimal distances between rf emitters and other types of base activities for planning and siting purposes. It is especially useful if the emitter is already present on the base and other facilities are being sited around it. In any case, the RF Survey is the best way to take into account the many variables that influence precise electromagnetic radiation intensities in various locations around an antenna. The complex influence of terrain, reflections, atmosphere, etc. are all naturally accounted for in such empirical measurements. The results of such measurements can be used to establish safe limits with a minimum of restrictions and minimum of curtailment to operations. Such measurements are absolutely essential if it is desired to operate an rf emitter closer than the theoretical minimum separation dictated by an RF Study, which tends to ignore special conditions that might make closer operation perfectly safe.

A.8 Conducting and Reporting an RF Survey

The conduct of an RF Survey requires the close cooperation of several different groups at the base or installation. Operations and maintenance are needed to ascertain normal and off-normal operating conditions of equipment and personnel. base planners and civil engineers are needed to cover the facility's layout and to determine the implications of siting decisions. Occupational safety and health experts are needed to evaluate health and safety concerns. Communications specialists are needed to conduct the survey itself and to interpret the results. In short, the conduct of an RF Survey is the best insurance against unexpected problems and assures maximum operational freedom, but it can be an involved and costly undertaking.

It is usually necessary to execute a theoretical RF Study as a precondition to an empirical RF Survey. This must be done so as to estimate safe parameters for conducting the measurements. After all the personnel and equipment conducting the survey must themselves be protected against unacceptable hazards in collecting the data. An example of some of the theoretical data that might be used in such a preliminary study is shown in Figure A2. The figure portrays the worst case for an Air Force AN/GPN-22 radar antenna on a high-power setting with a stopped beam. The minimum permissible distances along the beam axis are depicted for various Electromagnetic Radiation Hazards (EMRHs) denoted by letter codes.

The letter codes and operational characteristics for this type of antenna are also provided in Figure A-2. This is just one example of many such diagrams that abound for the numerous and varied antennas that accompany military bases and installations.

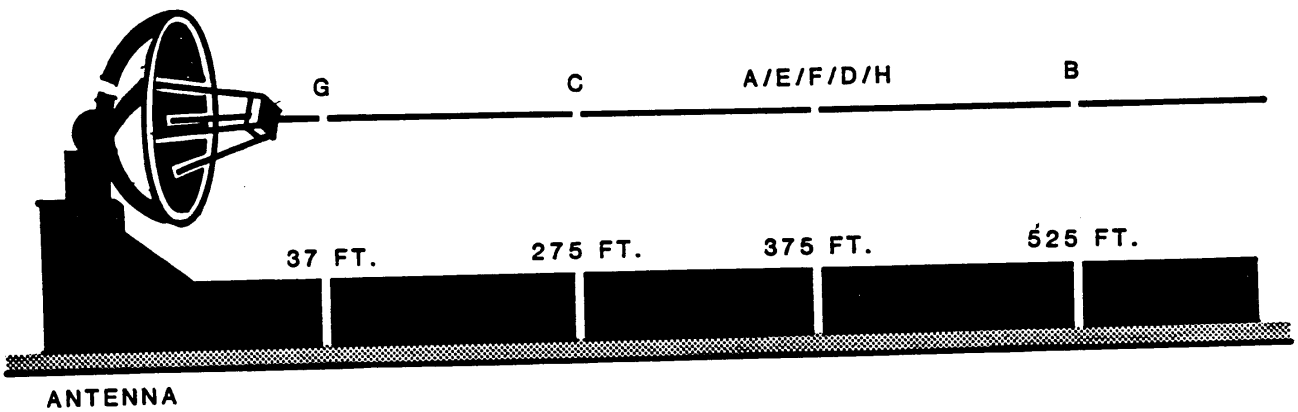
In addition, as a part of any RF Survey, a decision must be made whether or not to create an RF Hazard Drawing for the facility in question. This drawing would depict the various restricted zones around the emitting device as they apply to a given installation. It would depict the effects of terrain as well as other important operational features. For example, such an rf hazard drawing might show how a given powerful radar would have its beam blanked as it passes by a tall building. Such rf hazard drawings are usually accomplished by the Air Force Communications Command (AFCC) and are retained in the BCE facility records.

Diagram of Safe Distances from Antenna AN/GPN-22

Figure A-2

AN/GPN-22

Frequency:	9.0 - 9.2 GHz	
Peak Power:	250 kW	
Avg Power:	913 W	
Pulse Width:	1.0 µs	
PRF:	3652	
Duty Cycle:	0.003652	
Antenna:		
Gain:	39.5 - 42.5 dBi	
Size:	15 ft	(H)
	13 ft	(V)
Beamwidth:	1.3	(H)
	0.75	(V)



A -- Adult (persons greater than or equal to 55 inches tall)

B -- Small Size Human (persons less than 55 inches tall)

C -- Fuels

D -- Exposed EEDs

E -- EEDs in Storage or Transport in Metal Container

F -- EEDs in Storage or Transport in Nonmetal Container

G -- EEDs in Parked/Taxiing Aircraft

H -- EEDs in Aircraft in Flight or Cargo Aircraft

Source: Air Force Communications Command

APPENDIX B

MODEL STATEMENT OF WORK FOR A CONTRACTED COMMUNICATIONS SYSTEMS PLAN

The Communications Systems Plan component of The Plan should contain a complete description and evaluation of the current and future conditions of each communications system on the installation. The Communications Systems Plan will vary according to the needs and conditions at each installation, but it should contain, at a minimum, consideration of: telephone, radio, NAVAIDS, weather, alarm, microwave, satellite and video systems.

The work to be performed in conjunction with the Communications Systems Plan component includes the following items:

1. Introduction, methodology and summary of findings;
2. Statement of utilities systems goals and objectives;
3. Review and evaluation of existing conditions;
4. Identification of problems, constraints, and opportunities;
5. Development and review of plan alternatives;
6. An evaluation of alternatives;
7. Recommended plan; and
8. A plan implementation strategy.

These sections of the Communications Systems Plan should take the reader through an orderly, sequential process of understanding the context for the plan, the approaches used, and what was found to exist, alternative plan elements, and the final plan and its implementation.

1. Introduction, Methodology and Summary of Findings

The introduction should describe the purpose of the Communications Systems Plan, the installation location and elation to the surrounding region, points of contact on installation, a summary of the installation needs, and highlights of the recommended plan. A person reading only the introduction should be able to understand the primary elements of the plan.

2. Goals and Objectives

The overall physical and functional communications systems goals and objectives should be presented. These guide the Communications Systems Plan's development and ensure the plan is in concert with other components of the Base Comprehensive Plan/Installation Comprehensive Master Plan.

3. Review and Evaluation of Existing Conditions

Existing communications systems and their condition, location, and relation to each other should be clearly described. The narrative should cover the important aspects of each communication system category as stated above. Tables should be used to summarize important data and existing communications systems conditions and capacity. The Tabs/existing conditions maps described in Appendix C should be prepared. (Tab H Series for the Air Force)

4. Problems, Constraints, and Opportunities

Describe the current problems, constraints, and opportunities identified during existing conditions inventory. Include a detailed description of what the problems are and the probable causes. Describe any physical, environmental,. legal, and other constraints on planning or development. Also, identify existing facilities or conditions that provide opportunities for improved communications systems. Include off-installation problems and opportunities to the extent that they will affect planning.

Prepare a composite map showing locations of problems and opportunities along with a short narrative of each that is number-keyed to the map. Where feasible, forecast potential future problems resulting from communications systems or mission changes. Indicate future problems on the same map using a special color or symbol, or by means of an overlay.

5. Alternatives

Review each current communication system's capability of supporting the installation's planned future growth and development. For each current and future problem/opportunity (particularly in concert with the Utilities and Transportation Plans), describe the feasible alternatives. Use a tabular format to clearly display alternatives. Prepare sketches of alternatives, particularly changes that are otherwise difficult to visualize. These might include physical alterations such as realignments, demolition, and construction alternatives.

6. Evaluation of Alternatives

Evaluate the alternatives and describe how the evaluation was conducted and the results for each problem or opportunity identified. Include a list of criteria and standards used for evaluation purposes. Provide tables showing the comparison of alternatives. Conclude with a ranking of all alternatives.

7. Recommended Plan

Describe the communications systems required to meet current and future mission needs. Prepare tables and maps showing the future recommended communications alignments and requirements both short-term and long-term. Prepare a table showing the total cost to implement the short-term and long-term requirements.

8. Plan Implementation

Describe steps that should be taken to implement the recommended projects. Include coordination needed among installation personnel and off-installation agencies. Develop specific policies, programs, and projects that will implement the future communications systems plan. To the extent possible, also describe known off-installation projects that will influence the installation. Provide illustrations or maps to supplement the narrative.

APPENDIX C

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APPENDIX D

GLOSSARY

Airport Surface Detection Equipment (ASDE) - a radar-based, local object detection system permitting airfield personnel to monitor the movement of aircraft on the ground during periods of reduced visibility.

Airport Surveillance Radar (ASR) - a radar-based, NAVAIDS system used to monitor and control air traffic around an airfield, generally within a range of about 60 nautical miles.

Air Traffic Control (ATC) Tower (ATCT) - a structure in the form of a tower, typically with an observation area at the top. This structure is used to control the movements of aircraft operations at an airfield.

Closed - Circuit Television (CCTV) - a local television receiver or network of television receivers that derives its video signals from direct hard-wired connection to a local video source rather than by means of electromagnetic radiation through the air.

Compass Location (COMCO) - a NAVAIDS device that radiates a non-directional radio signal providing an airplane pilot with directional guidance information concerning the orientation of the aircraft with regard to the antenna location. Similar to a Non-directional Beacon (NDB).

Defense Communication System (DCS) - a world-wide long-haul communications network serving the U.S. Army, Navy, Air Force and Marine Corps and some other government agencies. It consists of over 60,000 circuits connecting more than 70 countries.

Distance Measuring Equipment (DME) - the civilian version of the Tactical Air Navigation (TACAN) system, which provides an airplane pilot with continuous information concerning range or distance from the airfield.

Electro - Explosive Device (EED) - an item of ordnance or munitions that is detonated by an electrical or electronic device.

Electromagnetic Interference (EMI) - the interference caused in one communications channel by the presence of nearby electromagnetic radiation, usually the result of communications over another channel.

Electromagnetic Radiation Hazard (EMRH) - a potentially dangerous situation caused by the local presence of electromagnetic of radio-frequency radiation of a certain intensity or field strength near people (see HERP), fuel (see HERF) or certain types of ordnance (see HERO).

Extremely High Frequency (EHF) - electromagnetic radiation in the 30 GHz to 300 GHz frequency range.

Fiber Optics - a physical communications channel through a cable composed of strands of glass fiber, permitting transmission of information at optical/frequencies, thereby greatly increasing communications bandwidth and capacity over traditional channels.

Forward Clearance Zone - the land area immediately in front of the Reflection Zone for a directional polarizing antenna. This area has the same angular width as the Reflection Zone and extends further out than the Reflection Zone to insure proper, obstruction-free, forward propagation of the signal.

Giga - Hertz (GHz) - a frequency of oscillation or radiation equal to one billion (1,000,000,000) cycles or repetitions per second.

Hazards of Electromagnetic Radiation to Fuel (HERF) - a dangerous situation caused by local electromagnetic radiation that has the potential to spontaneously ignite fuel located in the area.

Hazards of Electromagnetic Radiation to Ordnance (HERO) - a dangerous situation caused by local electromagnetic radiation that has the potential to spontaneously detonate certain kinds of munitions or ordnance located in the area.

Hazards of Electromagnetic Radiation to Personal (HERP) - a dangerous situation caused by local electromagnetic radiation that has the potential to damage the health of personnel located in the area.

High Frequency (HF) - electromagnetic radiation in the 3 MHz to 30 MHz frequency range.

Instrument Landing System (ILS) - an electronic, radio-based system that provides aircraft with the lateral, longitudinal and vertical guidance necessary to execute a safe landing, particularly • under conditions of severely reduced visibility.

Kilo-Hertz (KHz) - a frequency of oscillation or radiation equal to one-thousand (1000) cycles or repetitions per second.

Line-of-Sight (LOS) - a straight line path from the source to the receiver.

Low Frequency (ll) - electromagnetic radiation in the 30 KHz to 300 KHz frequency range.

Medium Frequency (MF) - electromagnetic radiation in the 300 kHz to 3 MHz frequency range.

Mega-Hertz (MHz) - a frequency of oscillation or radiation equal to one million (1,000,000) cycle or repetitions per second.

Micro-wave Landing System (MLS) - an electronic, micro-wave based system that provides aircraft with the azimuth (horizontal angle) and elevation (vertical descent) guidance necessary to execute a safe landing. Range information is usually provided by Distance Measuring Equipment (DME). The ILLS is a modern replacement for the conventional Instrument Landing System (11-5).

Navigational Aids (NAVAIDS) - communications, signals, channels and facilities designed to assist aircraft operations at or near an airfield.

Non-directional Beacon (NDB) - a NAVAIDS device that radiates a non-directional radio signal providing a pilot with directional guidance information concerning the orientation of the aircraft with regard to the antenna location. Similar to a Compass Locator(COMCO).

Non-secure Communications - information that has not been specially encoded or encrypted and can sometimes be relatively easily intercepted by unauthorized parties.

Obstruction Angle - the angle in degrees that a partial obstruction may enter the predicted wavepath of a Radio Frequency (RF) signal.

Obstruction Clear Horizon Profile - a vertical slice through the earth's surface in a certain direction from the center of an antenna to the point where a direct ray or LOS path touches the horizon. This profile should be free from obstructions in the form of buildings, structures, local halls, etc.

Private Automatic Branch Exchange (PABX) - a local, private telephone switching device that automatically connects any dialed telephone extensions that are on a given private telephone system.

Pulsed-type Emission - communications information or signals that are sent in the form of repeated bursts or pulses of energy rather than as a steady emission.

Radio Frequency (RF) - electromagnetic radiation in the frequency range from the audio spectrum (20 Hz) to the optical spectrum (400 mili-microns), embracing all frequencies from Very 1~)w Frequency (VI-F) to Extremely High Frequency (EHF).

Radio-Frequency interference (RFT) - the interference caused in one communications channel by the presence of nearby electromagnetic radiation in the radio-frequency (RF) range. The interfering radio frequency radiation is usually the result of communications over another channel.

Receiver Site - the physical location and layout of a communications facility designed to receive information over one or more communications media.

Reflection Zone - the land area immediately below and in front of a directional polarizing antenna that is needed to form the ground reflection lobe for effective signal propagation into the atmosphere.

Secure Communications - information that has been specially encoded or encrypted for security reasons so as to make unauthorized interception difficult or impossible.

Set Back - the distance between a communications facility and the nearest object or structure that could interfere with the communications facility.

Super-High Frequency (SHF) - electromagnetic radiation in the 3 GHz to 30 GHz frequency range.

Synchronous Orbit - an orbit for an artificial satellite that maintain a constant relationship with some object or place on earth. The typical (geo) synchronous orbit for a communications satellite locates the satellite always directly above the same spot on the earth's surface, thus facilitating the aiming of antennas toward that satellite.

Tactical Air Navigation (TACAN) - the military version of Distance Measuring Equipment (DME), which provides an airplane pilot with continuous information concerning range or distance from the airfield.

Take-off Angle Clearance - the obstruction-free area needed in front of a directional antenna in order to assure that the radiated signal can effectively propagate at the lowest angle required relative to the earth's horizon.

Transmitter Site - the physical location and layout of a communications facility designed to transmit or send information over one or more communications media.

Terminal Very High Frequency Omni-Range (TVOR) - an airfield version of enroute Very-High Frequency Omni-Range (VOR), which provides a pilot with azimuth (horizontal angle) information concerning the orientation of the aircraft with regard to the antenna location.

Ultra-High Frequency (UHF) - electromagnetic radiation in the 300 MHz to 3 GHz frequency range.

Uniform - Horizon Mask - the obstruction of the earth's horizon by a circular hill, barrier or berm of the same height in all directions.

Very High Frequency (VHF) - electromagnetic radiation in the 30 MHz to 300 MHz frequency range.

Very Low Frequency (VLF) - electromagnetic radiation in the 3 KHz to 30 KHz frequency range.